



**Aeronautical  
Engineering**  
A Continuing  
Bibliography  
with Indexes

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April 1985

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National Aeronautics and  
Space Administration

## Aeronautical Engineering

Pages 137-198

April 1985

Engineering Aeronautical Engineering  
SPECIAL NOTICE ENCLOSED  
NEW FOREIGN TECHNOLOGY INDEX INCLUDED IN THIS ISSUE  
Engineering Aeronautical Engineering





## ACCESSION NUMBER RANGES

Accession numbers cited in this Supplement fall within the following ranges.

STAR (N-10000 Series)	N85-13766 - N85-15656
IAA (A-10000 Series)	A85-15967 - A85-19101

# **SPECIAL NOTICE**

## **FOREIGN TECHNOLOGY INDEX IN THIS ISSUE**

Documents referred to in this bibliography whose country of intellectual origin is other than the United States are listed in the Foreign Technology Index (see page D-1).

A great deal of excellent scientific and technical work is done throughout the world. To the extent that U.S. researchers, engineers, and industry can utilize what is done in foreign countries, we save our resources. We can thus increase our country's productivity.

We are testing out this approach by helping readers bring foreign technology into focus. We would like to know whether it is useful, and how it might be improved.

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Foreign Technology Index:

- ☐ Isn't useful, so should be discontinued.
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# AERONAUTICAL ENGINEERING

## A CONTINUING BIBLIOGRAPHY WITH INDEXES

(Supplement 186)

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced in March 1985 in

- *Scientific and Technical Aerospace Reports (STAR)*
- *International Aerospace Abstracts (IAA).*



Scientific and Technical Information Branch

1985

**National Aeronautics and Space Administration**

Washington, DC

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# INTRODUCTION

Under the terms of an interagency agreement with the Federal Aviation Administration this publication has been prepared by the National Aeronautics and Space Administration for the joint use of both agencies and the scientific and technical community concerned with the field of aeronautical engineering. The first issue of this bibliography was published in September 1970 and the first supplement in January 1971.

This supplement to *Aeronautical Engineering -- A Continuing Bibliography* (NASA SP-7037) lists 419 reports, journal articles, and other documents originally announced in March 1985 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*.

The coverage includes documents on the engineering and theoretical aspects of design, construction, evaluation, testing, operation, and performance of aircraft (including aircraft engines) and associated components, equipment, and systems. It also includes research and development in aerodynamics, aeronautics, and ground support equipment for aeronautical vehicles.

Each entry in the bibliography consists of a standard bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged by the first nine *STAR* specific categories and the remaining *STAR* major categories. This arrangement offers the user the most advantageous breakdown for individual objectives. The citations include the original accession numbers from the respective announcement journals. The *IAA* items will precede the *STAR* items within each category.

Seven indexes -- subject, personal author, corporate source, foreign technology, contract number, report number, and accession number -- are included.

An annual cumulative index will be published.

# AVAILABILITY OF CITED PUBLICATIONS

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All publications abstracted in this Section are available from the Technical Information Service, American Institute of Aeronautics and Astronautics, Inc. (AIAA), as follows: Paper copies of accessions are available at \$8.50 per document. Microfiche<sup>(1)</sup> of documents announced in *IAA* are available at the rate of \$4.00 per microfiche on demand. Standing order microfiche are available at the rate of \$1.45 per microfiche for *IAA* source documents.

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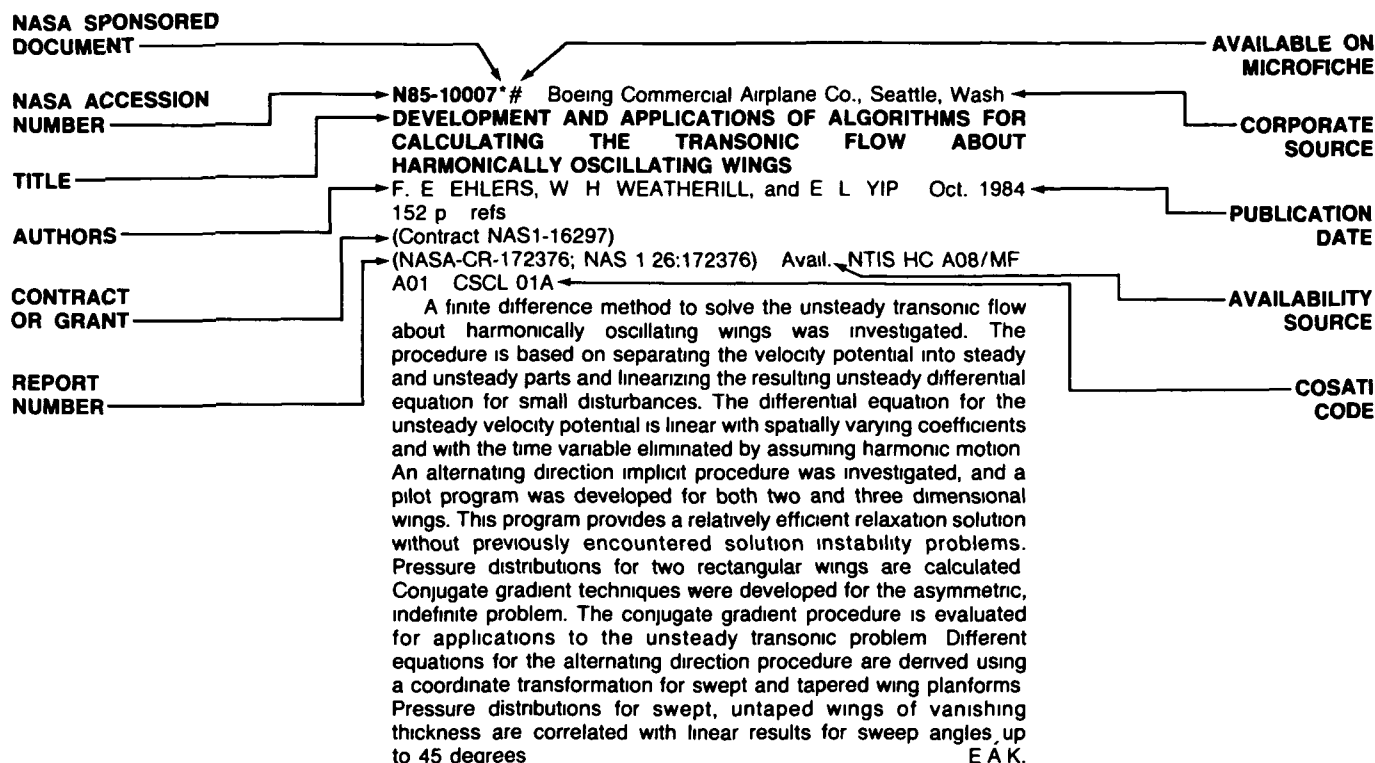
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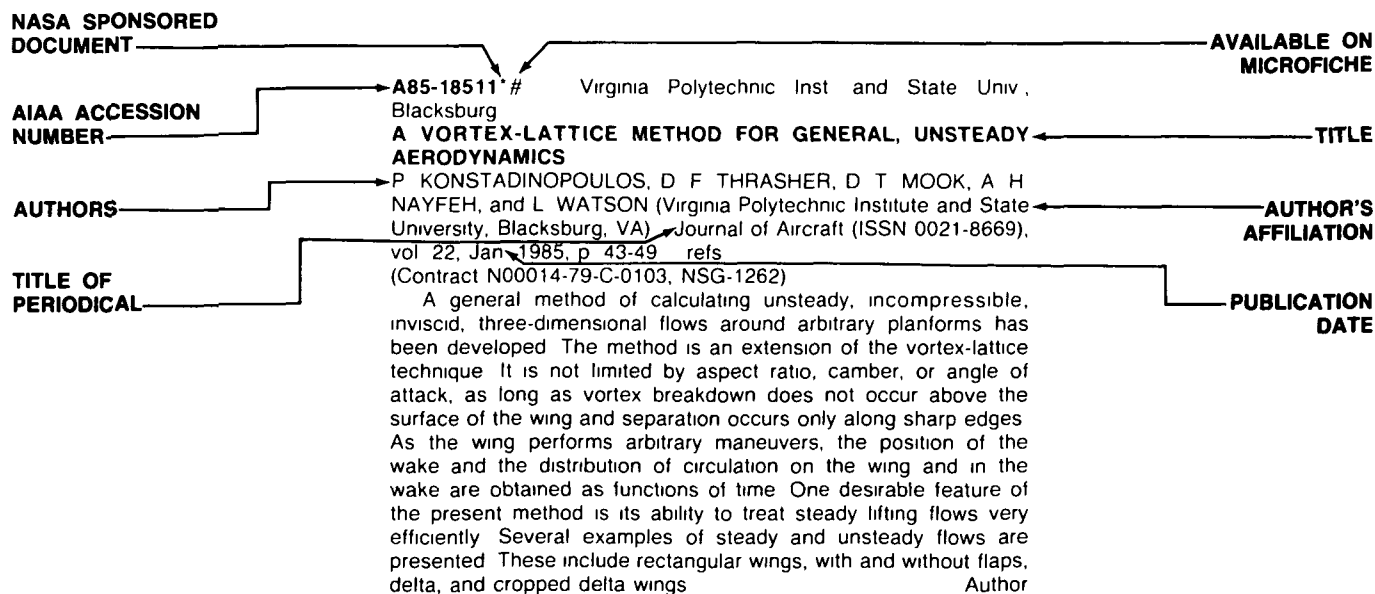
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# AERONAUTICAL ENGINEERING

*A Continuing Bibliography (Suppl. 186)*

APRIL 1985

01

## AERONAUTICS (GENERAL)

**A85-16066**

### **PRINCIPAL TESTS FOR THE AUTOMATED PRODUCTION OF THE AIRBUS FIN ASSEMBLY WITH FIBER COMPOSITE MATERIALS**

B SARH (Messerschmitt-Boelkow-Blohm GmbH, Hamburg, West Germany, MIT, Cambridge, MA) IN Technology vectors, Proceedings of the Twenty-ninth National SAMPE Symposium and Exhibition, Reno, NV, April 3-5, 1984. Covina, CA, Society for the Advancement of Material and Process Engineering, 1984, p. 1477-1488.

Automated production of the A300 composite Fin Box, which favors the selection of a modular construction technique, makes possible an economical series production of aircraft primary structure. The successful development and testing of the production technology entails construction of a high pressure water jet station for precision cutting of the prepreg, transportation of the prepreg bandages with a robot-driven vacuum drum, wrapping aluminum cores with the prepreg at a bandaging station, transferring the wrapped cores with a robot, laying up stringer strips with a robot-controlled laying head. In addition, large composite tools (12 m x 3 m, i.e., 36 ft x 9 ft) and automated tools for the structure were successfully developed and tested for series production. The know-how gained in the production technology provides a substantial contribution towards automation of composite aircraft production in the future. Author

**A85-16244**

### **REPAIR OF MIRAGE III AIRCRAFT USING THE BFRP CRACK-PATCHING TECHNIQUE**

A. A. BAKER, R. J. CALLINAN, M. J. DAVIS, R. JONES, and J. G. WILLIAMS (Defence Science and Technology Organisation, Aeronautical Research Laboratories, Melbourne, Australia) Theoretical and Applied Fracture Mechanics (ISSN 0167-8442), vol 2, Oct. 1984, p. 1-15 refs

The experience in developing and applying BFRP (boron fiber reinforced plastic) patches to fatigue cracks in the aluminum-alloy wing skins of the Mirage III fighter aircraft is described. BFRP advantages include excellent resistance to corrosion and cyclic loading, ease of production, a high thermal expansion coefficient and the fact that the crack can be inspected through the patch by eddy-current NDI. Finite-element procedures, used in patch design and BFRP repair, qualified by using fatigue-crack propagation studies on panels simulating the cracked and repaired area, are discussed. A Crack Patching Unit (CPU) was constructed to allow repairs to be carried out by specially trained service personnel during routine aircraft servicing. This repair has been applied to over 150 wings in service and, while some crack growth was reported, the patch stopped further growth and no wing skin has required further repair. M.D.

**A85-16245**

### **BONDED REPAIRS TO SURFACE FLAWS**

R. JONES and R. J. CALLINAN (Defence Science and Technology Organisation, Aeronautical Research Laboratories, Melbourne, Australia) Theoretical and Applied Fracture Mechanics (ISSN 0167-8442), vol 2, Oct. 1984, p. 17-25 refs

A method using BFRP (boron fiber reinforced plastic) patches for the repair of surface flaws in aluminum alloy aircraft components is presented. The method is best suited to cases where the cracking is primarily due to the presence of inclusions and the stress field is relatively low. A new procedure for repairing cracked bolt holes which involves the use of a bonded insert is also proposed. By using a bonded sleeve, significant reductions in the fretting at the hole and in the stress intensity factors along the crack front have been obtained. The design of preventative repair schemes is illustrated by considering a recent repair to a fairing attachment hole. Both methods, which involve the use of adhesive bonding, have been found to lead to increases in fatigue life. M.D.

**A85-17773**

### **LOCKHEED PUSHES STOL TECHNOLOGY**

H. LEVY Flight International (ISSN 0015-3710), vol 126, Nov 24, 1984, p. 1370-1372

The High Technology Test Bed (HTTB) aircraft for Short Takeoff and Landing (STOL) method development testing is a C-130 military transport that has been modified in order to increase lift coefficient from 2.5 to 4.92; this degree of efficiency will permit operations from roadways as small as 2000 ft long and 62 ft wide. Double-slotted trailing edge flaps and a full-span drooped leading edge will be fitted, together with longer chord ailerons and spoilers in order to improve HTTB controllability at the lower landing approach speeds that are made possible. Attention is also given to longer term design development projects with STOL capability, including a wing-in-ground effect aircraft. O.C.

**A85-17801**

### **DIGITAL AVIONICS SYSTEMS CONFERENCE, 6TH, BALTIMORE, MD, DECEMBER 3-6, 1984, PROCEEDINGS**

Conference sponsored by the American Institute of Aeronautics and Astronautics and Institute of Electrical and Electronics Engineers. New York, American Institute of Aeronautics and Astronautics, 1984, 704 p. For individual items see A85-17802 to A85-17902.

The present conference on digital avionics discusses development methods for avionics systems and their software, commercial transport aircraft applications, advanced avionics sensor systems, human factors and artificial intelligence issues in crew system design, digital flight control technology, evaluation tools, avionics for general aviation aircraft, fault-tolerant avionics design, advanced control/display systems for aircraft crews, and software verification and testing techniques. Also considered are rotorcraft avionics, data bus concepts and practices, the development and testing of crew systems, communication, navigation and identification terminals, ADA systems and their software, onboard monitoring and testing of avionics, VLSI avionics design and testing, data link applications, airborne separation assurance, all-electric aircraft, standardized modular avionics, and digital propulsion control and monitoring systems. O.C.

## 01 AERONAUTICS (GENERAL)

**A85-18163**

### **AIR TRAFFIC CONTROL AND AIRPORT AUTHORITIES - THE U.K. VIEWPOINT**

N. M. L. HUGHES (Barlow, Lyde & Gilbert, London, England) (European Study Conferences, Ltd., Aviation Law and Claims Conference, London, England, June 1984) Air Law (ISSN 0165-2079), vol 9, no 4, 1984, p 202-215. refs

The liability exposure of airport operators and providers of ATC services in the UK is evaluated. The airport licensing and regulation activities of the UK Civil Aviation Authority (CAA) and the British Airports Authority (BAA, managing the seven largest international airports) are reviewed, and the general responsibilities they place on the airport management to provide such services as safe physical facilities, adequate lighting, security, bird-hazard warning and control, rescue and medical services, runway-condition information, snow removal, and regular inspections are examined as they affect liability in the case of an accident. The statutes governing the provision of ATC services by the CAA are also summarized, and it is concluded that the airport operator and the CAA have extensive liabilities for their respective spheres of responsibility and little recourse to presumed or limited liability status. The restricted applicability of the doctrine of sovereign immunity of foreign powers to these types of litigation is indicated. T.K.

**A85-18712**

### **LONG-TERM PERSPECTIVES FOR AVIATION RESEARCH OF THE DFVLR [DIE LANGFRISTPERSPEKTIVE FUER DIE LUFTFAHRTFORSCHUNG DER DFVLR]**

F. THOMAS and H. DISSEN (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick, West Germany) DFVLR-Nachrichten (ISSN 0011-4901), vol 43, Nov 1984, p. 1-4. In German.

Aspects of success with respect to long-term considerations depend in the case of research conducted by the DFVLR on the realistic estimation of future developments in aviation. A brief summary is provided of the most important aspects of the long-term perspectives of the aviation-related research of the DFVLR. The DFVLR employs approximately 900 scientists, 400 of whom are occupied with problems concerning aviation. The problems are related to the automation of flight control and air traffic control, the guidance of aircraft including helicopters, the reduction of drag on the basis of the use of new profiles and wing forms, an aerodynamic design which provides aspects of low detectability and high mobility for a military aircraft, new concepts for aircraft engine components, approaches for assuring the reliability of fiber-reinforced materials, the cost-effective manufacture of aircraft components, and intelligent target recognition and weapon guidance. G.R.

### **N85-13766# Office National d'Etudes et de Recherches Aeronautiques, Paris (France). Direction de l'Aerodynamique MANUFACTURING REPORT OF AN AUGMENTED LIFT, VARIABLE DEFLECTION HALF WING [RAPPORT DE FIN DE FABRICATION DE LA DEMI-AILE HYPERSUSTENTEE A FLECHE VARIABLE]**

J. J. THIBERT Aug. 1984 15 p refs In FRENCH (Contract STPA-83-95-017)

(ONERA-RT-25/1736-AY-108-A) Avail: NTIS HC A02/MF A01

The manufacturing controls and characteristics of an augmented lift wing model with a deflection variable between 0 and 50 deg are reported. The wing is an RA16SCI profile with 2 m wing span. The augmented lift system is implemented with two wing tips and a flap with variable deflection. The controls show that the specified tolerances are respected. Author (ESA)

**N85-14786\*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va**

### **AN OVERVIEW OF SOME MONOPLANAR MISSILE PROGRAMS**

M. L. SPEARMAN Dec 1984 33 p refs Presented at the Joint Serv Guidance and Control Comm. Workshop on Bank-to-Turn Controlled Terminal Homing Missiles, Laurel, Md, 19-20 Sep 1984. Previously announced in IAA as A84-42280 (NASA-TM-86330, NAS 1.15:86330) Avail: NTIS HC A03/MF A01 CSCL 01B

A historical review is presented of some monoplane missile systems in which the vehicle flight control was similar to that for a conventional aircraft. The review is essentially chronological, beginning prior to World War I, and includes worldwide programs. Illustrative examples of aerodynamic research with monoplane missiles are presented including some comparisons with cruciform missiles. Some examples of current programs are presented and some particular mission applications for monoplane systems are discussed. Author (AIAA)

**N85-14787\*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va**

### **AERODYNAMIC CHARACTERISTICS OF SOME LIFTING REENTRY CONCEPTS APPLICABLE TO TRANSATMOSPHERIC VEHICLE DESIGN STUDIES**

M. L. SPEARMAN Dec 1984 31 p Presented at the AIAA 2nd Appl Aerodyn. Conf, Seattle, 21-23 Aug 1984. Previously announced in IAA as A84-41326

(NASA-TM-86331, NAS 1.15 86331, AIAA-PAPER-84-2146)

Avail: NTIS HC A03/MF A01 CSCL 01B

The aerodynamic characteristics of some lifting reentry concepts are examined with a view to the applicability of such concepts to the design of possible transatmospheric vehicles (TAV). A considerable amount of research has been done in past years with vehicle concepts suitable for manned atmospheric entry, atmospheric flight, and landing. Some of the features of these concepts that permit flight in or out of the atmosphere with maneuver capability should be useful in the mission requirements of TAV's. The concepts illustrated include some hypersonic-body shapes with and without variable geometry surfaces, and a blunt lifting-body configuration. The merits of these concepts relative to the aerodynamic behavior of a TAV are discussed. Author (IAA)

**N85-14788\*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.**

### **THE AERODYNAMICS OF SOME GUIDED PROJECTILES**

M. L. SPEARMAN Dec. 1984 24 p refs Previously announced in IAA as A84-42373

(NASA-TM-86334, NAS 1.15 86334) Avail: NTIS HC A02/MF A01 CSCL 01B

Some characteristic projectile shapes are considered with various added components intended to provide lift, stability, and control. The intent of the additions is to provide some means for altering the normal ballistic flight path of a projectile for various purposes such as achieving greater accuracy at the impact point, selecting alternate impact points, extending range, improved evasion, and so on. The configurations presented illustrate the effects of a flare, wings, and tails for providing stability and lift, and the effects of aft-tails, a close-coupled flap, and all-moving forward wings for control. The relative merits of the various configurations, all of which provided for flight path alterations are discussed. Author (AIAA)

**N85-14789# Joint Publications Research Service, Arlington, Va. CHINA REPORT: SCIENCE AND TECHNOLOGY**

17 Dec. 1984 110 p refs Transl into ENGLISH from various Chinese articles

(JPRS-CST-84-042) Avail: NTIS HC A06/MF A01

Activities are reported in the development and marketing of microcomputers and computer programs. The design and capabilities of supersonic fighter aircraft are discussed as well as the X-ray spectra of laser plasmas and a nuclear pumped X-ray

laser The use of a serum specific DNA polymerase in hepatitis B is recommended

**N85-14790#** Joint Publications Research Service, Arlington, Va  
**NEW FIGHTER AIRCRAFT REPORTED**  
*In its* China Rept. Sci. and Technol (JPRS-CST-84-042) p 19-20 17 Dec 1984 Transl into ENGLISH from Hangkong Zhishi (Beijing), no 10, Oct. 1984 p 22  
 Avail NTIS HC A06/MF A01

Assessments of Chinese aerotechnology as reported in U S periodicals are provided Particular emphasis is on the delay (since 1970) in producing the F-8 delta wing fighter aircraft. The principal reason for this delay is considered to be the inability to produce a suitable jet engine to power the aircraft A R H

**N85-14791#** Joint Publications Research Service, Arlington, Va  
**F-7 SUPERSONIC DAY FIGHTER VIEWED**  
*L ZHEN In its* China Rept. Sci and Technol (JPRS-CST-84-042) p 21-24 17 Dec 1984 Transl into ENGLISH from Guoji Hangkong (Beijing), no 9, 5 Sep. 1984 p 4-5  
 Avail NTIS HC A06/MF A01

Produced in China in the mid-1960's, the Jian-7 aircraft is a delta wing with nose air intake. The airframe is mainly of aluminum alloy and the power plant is one turbojet engine with an afterburning thrust of 5,100 kilograms High altitude maximum speed is about Mach 2 Improvements made to permit the aircraft to remain airborne longer, to assure reliability of the ejection seats, and to facilitate adjustment of the air intake ducts are cited A cannon was also added to augment close-combat firepower The armament on the aircraft and fire control electronic equipment are also described A R H

**N85-14792#** Joint Publications Research Service, Arlington, Va  
**A-5 SUPERSONIC ATTACK AIRCRAFT DESCRIBED**  
*K. MIN In its* China Rept. Sci and Technol (JPRS-CST-84-042) p 25-28 17 Dec 1984 Transl. into ENGLISH from Guoji Hangkong (Beijing), no 9, 5 Sep 1984 p 2-3  
 Avail NTIS HC A06/MF A01

Technical and tactical data are presented for the Qiang-5 aircraft designed for the high-speed penetration of defenses at low or minimum altitudes to provide close air support to ground units First test flown in 1965, the aircraft can attack many kinds of ground targets and can conduct both level bombing and dive bombing attacks Its cannons and rockets can be used in self-defensive aerial combat and the aircraft can also carry air-to-air missiles A R H

**N85-14793#** Joint Publications Research Service, Arlington, Va  
**DETAILS OF EXPORT A-5 CLOSE-SUPPORT AIRCRAFT GIVEN**

*In its* China Rept. Sci and Technol (JPRS-CST-84-042) p 29-32 17 Dec. 1984 Transl into ENGLISH from Hangkong Zhishi (Beijing), no. 9, Sep. 1984 p 12-13  
 Avail NTIS HC A06/MF A01

Designated the Fantan A aircraft by NATO, China's A-5 aircraft is a single seat, twin engined supersonic attack aircraft that is capable of level flying as well as diving to execute its air to surface mission Air to air missiles and guns are used for its defense Technical specifications of the aircraft and its performance characteristics are discussed A R H.

**N85-14807\*#** National Aeronautics and Space Administration  
 Ames Research Center, Moffett Field, Calif.  
**SUPERAUGMENTED ROTORCRAFT PROGRAM**  
 R D. SHOWMAN *In its* Technical Workshop Advanced Helicopter Cockpit Design Concepts p 7-12 Dec 1984  
 Avail NTIS HC A15/MF A01 CSCL 01B

Concepts, design criteria, and methodology will be examined in four areas control systems, guidance systems, cockpit dialogue systems, and the integrated intelligence The approach is to investigate these areas in an individual manner through analysis and simulation and in an integrated manner through simulation

and flight Finally, the integrated concepts will be validated in flight. B G

**N85-14810\*#** Army Aviation Center, Fort Rucker, Ala  
**ARMY AVIATION TODAY AND TOMORROW**  
 G PHILIPS *In* NASA Ames Research Center Technical Workshop Advanced Helicopter Cockpit Design Concepts p 35-54 Dec 1984

Avail: NTIS HC A15/MF A01 CSCL 01B

Military helicopters and their functions in combat are described Electronic countermeasures, target acquisition, surveillance, reconnaissance, weapons systems, night flight capability, troop transport, and nap-of-the-earth navigation are discussed B.G

**N85-14811\*#** Marine Corps Tactical Systems Support Activity, Camp Pendleton, Calif  
**MARINE HELICOPTER MISSIONS**

S HILL *In* NASA. Ames Research Center Technical Workshop Advanced Helicopter Cockpit Design Concepts p 55-74 Dec 1984

Avail NTIS HC A15/MF A01 CSCL 01B

The four different helicopters in the Marine Corps inventory and the mission of each one described B G

**N85-14812\*#** National Aeronautics and Space Administration  
 Ames Research Center, Moffett Field, Calif

**CIVIL LAW ENFORCEMENT MISSIONS**

R M MORRISON (Huntington Beach Police Dept, Calif) *In its* Technical Workshop Advanced Helicopter Cockpit Design Concepts p 75-80 Dec 1984

Avail NTIS HC A15/MF A01 CSCL 01B

The user requirements for law enforcement, fire departments, paramedic, rescue, conservation and federal government agencies who use helicopters as a routine part of their operations are discussed. B G

**N85-14813\*#** Sikorsky Aircraft, Stratford, Conn  
**SAR MARITIME MISSIONS**

D A YOUNG *In* NASA Ames Research Center Technical Workshop. Advanced Helicopter Cockpit Design Concepts p 81-94 Dec 1984

Avail NTIS HC A15/MF A01 CSCL 01B

The U S Coast Guard missions (search and rescue, enforcement of laws and treaties, marine environmental patrol, and light utility transport) are discussed B.G

## 02

### AERODYNAMICS

Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces, and internal flow in ducts and turbomachinery

**A85-16105\*#** National Aeronautics and Space Administration.  
 Ames Research Center, Moffett Field, Calif

**APPLICABILITY OF A PANEL METHOD, WHICH INCLUDES NONLINEAR EFFECTS, TO A FORWARD-SWEPT-WING AIRCRAFT**

J C ROSS (NASA, Ames Research Center, Moffett Field, CA) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct 31-Nov 2, 1984 9 p refs (AIAA PAPER 84-2402)

The ability of a lower order panel method VSAERO, to accurately predict the lift and pitching moment of a complete forward-swept-wing/canard configuration was investigated The program can simulate nonlinear effects including boundary-layer displacement thickness, wake roll up, and to a limited extent, separated wakes The predictions were compared with experimental data obtained using a small-scale model in the 7- by 10- Foot Wind Tunnel at NASA Ames Research Center For the particular

configuration under investigation, wake roll up had only a small effect on the force and moment predictions. The effect of the displacement thickness modeling was to reduce the lift curve slope slightly, thus bringing the predicted lift into good agreement with the measured value. Pitching moment predictions were also improved by the boundary-layer simulation. The separation modeling was found to be sensitive to user inputs, but appears to give a reasonable representation of a separated wake. In general, the nonlinear capabilities of the code were found to improve the agreement with experimental data. The usefulness of the code would be enhanced by improving the reliability of the separated wake modeling and by the addition of a leading edge separation model. Author

A85-16147

# WAKE FLOW PAST A PLATE WITH SPOILER

P. BASSANINI (Roma, Università, Rome, Italy) Zeitschrift fuer angewandte Mathematik und Physik (ISSN 0044-2275), vol 35, Sept. 1984, p 658-670. Research sponsored by the Consiglio Nazionale delle Ricerche and Ministero della Pubblica Istruzione. refs

The flow past a flat plate with a flap raised either on the suction side (spoiler) or the pressure side (split flap) is investigated analytically, applying the finite-wake model proposed by Bassanini (1970) on the basis of the free-streamline wake model of Wu (1962). The model equations for the inverse problem of the spoiler case are solved analytically, and an expression for the Blasius force is derived. A numerical solution for the direct problem is obtained by cross-plotting or shooting computations starting from the inverse solutions, and drag-coefficient and incremental-lift values are compared with experimental data in graphs. Analysis of the split-flap problem demonstrates the existence of wakes with zero drag or overpressure. T K

A85-16152

# THE EFFECT OF THE DEFORMATION OF THE PARACHUTE MATERIAL ON THE AEROELASTIC CHARACTERISTICS OF THE PARACHUTE DURING OPENING [VLIANIE DEFORMATSII MATERIALA PARASHIUTA NA EGO AEROUVRUGIE KHARAKTERISTIKI PRI RASKRYTII]

I V DNEPROV and R. KHUDAIBERDIEV (Tashkentskii Politehnicheskii Institut, Tashkent, Uzbek SSR) Akademii Nauk Uzbekskoi SSR, Doklady (ISSN 0134-4307), no 7, 1984, p 16-19. In Russian

The effect of the deformation characteristics of the material on the aeroelastic characteristics of an opening axisymmetric parachute is investigated using an aeroelastic model incorporating three groups of equations. These are Rakhmatulin's (1975) equations in the dynamic form, ballistic equations, and equations of nonlinear aerodynamics (the discrete vortex method). A specific example is presented. V.L.

A85-16177

# DEVELOPMENT OF ARTIFICIALLY INDUCED PERTURBATIONS IN A SUPERSONIC BOUNDARY LAYER [RAZVITIE ISKUSSTVENNO VYZVANNYKH VOZMUSHCHENII V SVERKHZVUKOVOM POGRANICHNOM SLOE]

A. D. KOSINOV and A. A. MASLOV Akademii Nauk SSSR, Izvestia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), Sept-Oct. 1984, p 37-43. In Russian. refs

A method is proposed which uses an ac discharge to produce perturbations of regular amplitude in a supersonic boundary layer. This method is used to conduct an experimental study of the development of a three-dimensional low-intensity wave packet at a frequency of 20 kHz in the boundary layer on a flat plate at a Mach number of 2.0. The Fourier components of the wave packet are determined. The data obtained are compared with calculations of the linear stability of a supersonic boundary layer carried out in the plane-parallel flow approximation. L.M.

A85-16181

# PROPULSIVE EFFICIENCY OF AN OSCILLATING CYLINDER IN SUPERSONIC FLOW [O PROPUL'SIVNOM K.P.D. VIBIRIUSHCHEGO TSILINDRA V SVERKHZVUKOVOM POTOKE]

M V USTINOV Akademii Nauk SSSR, Izvestia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), Sept-Oct. 1984, p 130-135. In Russian.

The method of Kogan and Ustinov (1984) is used to treat the problem of the maximum efficiency of a cylinder with an oscillating inner or outer surface in supersonic flow. The problem is considered in the framework of linear theory and the gas flow is considered to be potential. A formula is obtained which can be used to calculate the efficiency of an oscillating cylinder in cases of inner and outer flow, as well as to calculate the efficiency of an oscillating plate. L.M.

A85-16182

# OPTIMIZATION OF THE AERODYNAMIC CHARACTERISTICS OF CARET WINGS AT SUPERSONIC FLIGHT SPEEDS [OPTIMIZATSIYA AERODINAMICHESKIKH KHARAKTERISTIK LAMBDA-KRYL'EV NA SVERKHZVUKOVYKH SKOROSTIYKH POLETA]

V. I. VORONIN and A. I. SHVETS Akademii Nauk SSSR, Izvestia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), Sept-Oct. 1984, p 136-140. In Russian. refs

An exact solution is obtained for supersonic flow past caret wings with breaks in the transverse and longitudinal contours. Solutions were constructed for caret wings with a break in the longitudinal contour whose lower surface formed shock-shock and shock-rarefaction wave systems. The optimization of the aerodynamic characteristics was carried out for  $V = \text{const}$ . Calculations for a constant lift coefficient and a constant volume coefficient show that only a slight gain in aerodynamic performance is achieved compared to a caret wing without a break. L.M.

A85-16183

# SUPERSONIC MOTION OF BODIES IN A GAS WITH SHOCK WAVES [SVERKHZUKOVOE DVIZHENIE TEL V GAZE S UDARNYMI VOLNAMI]

V. F. KAMENETSKII and L. I. TURCHAK Akademii Nauk SSSR, Izvestia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), Sept-Oct. 1984, p 141-147. In Russian. refs

A grid-characteristic method is used to analyze the diffraction of a plane shock wave by a blunt body moving at a supersonic velocity, with separation of a head shock. The method is modified for the calculation of flows with internal shocks in such a way that acoustic velocity and entropy are taken as the unknown thermodynamic parameters. Results are presented on flow past bodies with spherical or flat bluntness for different velocities of the body and different types of shock wave interaction (oncoming and overtaking). A comparison is made with experimental data, and it is noted that the proposed method is confirmed by numerical results. L.M.

A85-16184

# DESIGN OF ASYMMETRIC NOZZLES OF MAXIMUM MOMENT UNDER ADDITIONAL CONDITIONS ON GEOMETRIC AND FORCE CHARACTERISTICS [POSTROENIE NESIMMETRICHNYKH SOPEL MAKSIMAL'NOGO MOMENTA PRI DOPOLNITEL'NYKH USLOVIYAKH NA GEOMETRICHESKIE I SILOVYE KHARAKTERISTIKI]

A. I. RYLOV Akademii Nauk SSSR, Izvestia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), Sept-Oct. 1984, p 148-152. In Russian.

Kraiko's (1979) method of an indeterminate control profile is used to solve the variational problem involving the design of asymmetric two-dimensional nozzles for a maximum moment with respect to a certain point. The solution to this problem contains as a particular case the problem of designing a nozzle of maximum thrust, including the case of a specified lift force. It is shown that the design of a nozzle of maximum moment with additional conditions on thrust, lift or moment can be reduced to the design



of a nozzle of maximum moment with respect to a certain auxiliary point L M

**A85-16185**

**NUMERICAL ANALYSIS OF THE COMBINED FLOW OF A REACTION JET AND AN EXTERNAL STREAM WITH ALLOWANCE FOR THE EFFECT OF BOUNDARY LAYERS AND A TURBULENT MIXING ZONE [CHISLENNOE ISSLEDOVANIE SOVMESTNOGO TECHENIIA REAKTIVNOI STRUI I VNESHNEGO POTOKA S UCHETOM VLIANIYA POGRANICHNYKH SLOEV I TURBULENTNOI ZONY SMESHENIIA]**

N L EFREMOV and R K TAGIROV Akademii Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), Sept-Oct 1984, p 153-160 In Russian. refs

A mathematical description is given of the combined flow of external and internal viscous streams (two-dimensional or axisymmetric) The solution for each of the two flows is obtained through a time-differencing approach, with the combined solution obtained through iteration. The proposed method is used to construct algorithms and programs for performing the numerical analysis of several types of outlet-flow devices for constant values of the adiabatic exponent and stagnation temperature Numerical results are presented L M

**A85-16189**

**COMPUTATIONAL-EXPERIMENTAL STUDY OF A LAVAL NOZZLE WITH A CYLINDRICAL THROAT [RASCHETNO-EKSPERIMENTAL'NOE ISSLEDOVANIE SOPLA LAVALIA S TSILINDRICHESKOI GORLOVINOI]**

V M DVORETSKII, S D PANIN, and A A SHISHKOV Akademii Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), Sept-Oct. 1984, p 189-192 In Russian refs

Experimental and numerical results are presented concerning mixed flow and heat-transfer parameters in the transonic part of an axisymmetric Laval nozzle with a cylindrical throat, the profile having two breaks at the critical section. Numerical calculations of the flow field are made using Godunov's time-differencing approach A comparative analysis of static-pressure measurements and heat-transfer data indicates that the cylindrical section in the throat is responsible for flow separation at the profile break point and the generation of a shock during the subsequent reattachment of the jet to the wall. L M

**A85-16190**

**NUMERICAL ANALYSIS OF HEAT TRANSFER ON THE SURFACE OF A DELTA WING IN HYPERSONIC AIR FLOW AT LARGE ANGLES OF ATTACK [CHISLENNOE ISSLEDOVANIE TEPLOOBMENA NA POVERKHNOSTI TREUGOL'NOGO KRYLA OBTEKAEMOGO TIPHERZVUKOVYM POTOKOM VOZDUKHA POD BOL'SHIMI UGLAMI ATAKI]**

N E AFONINA, A I U. VLASOV, and V G GROMOV Akademii Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), Sept-Oct. 1984, p 196-199 In Russian refs

An analysis is made of heat transfer for a delta wing with blunt edges and different catalytic properties of the surface in hypersonic flow at attack angles of 40 and 60 deg; freestream Mach and Reynolds numbers are 24.1 and 0.85 x 10 to the 4th, respectively. The study employs a numerical model (using a conservative difference scheme) of the flow of a viscous reactive gas in a shock layer at the windward side of blunt elongated bodies The results indicate that the heterogeneous recombination of atoms has a significant effect on heat transfer L M

**A85-16217**

**A THEORY FOR A THREE-DIMENSIONAL HYPERSONIC VISCOUS SHOCK LAYER IN THE VICINITY OF A PLANE OF SYMMETRY [K TEORII PROSTRANSTVENNOGO GIPERZVUKOVOGO VIAZKOGO UDARNOGO SLOIA V OKRESTNOSTI PLOSKOSTI SIMMETRII]**

E A GERSHBEIN and S A IUNITSKII Prikladnaia Matematika i Mekhanika (ISSN 0032-8235), vol 48, Sept-Oct 1984, p 768-775 In Russian refs

Three-dimensional flow in a hypersonic viscous shock layer in the vicinity of a plane of symmetry is investigated over a range including moderately small to large Reynolds numbers A solution to the system of equations of the shock layer is sought in the form of series expansions in terms of the circular coordinate. A truncation procedure is proposed which makes it possible to close the system of equations for both the principal and subsequent terms of the expansion The resulting system of equations and boundary conditions is shown to provide an asymptotically adequate description of shock layer flow over the full range of Reynolds numbers that satisfy equations of the hypersonic viscous shock layer V L

**A85-16218**

**FREE PERTURBATIONS OF A LAMINAR HYPERSONIC FLOW BEHIND AN AIRFOIL [O SVOBODNYKH VOZMUSHCHENIIAKH LAMINARNOGO GIPERZVUKOVOGO TECHENIIA ZA PROFILEM]**

S V MANUILOVICH Prikladnaia Matematika i Mekhanika (ISSN 0032-8235), vol 48, Sept-Oct 1984, p. 776-781 In Russian refs

The study is concerned with plane-parallel laminar hypersonic flow behind an infinite-span wing at large distances from the latter In particular, attention is given to nonsymmetric free perturbations of principal flow described in terms of an explosion analogy The motion of gas satisfies the Navier-Stokes equations and is specified in terms of binomial asymptotic expansions The resulting symmetric and nonsymmetric perturbations of the explosion solution are oscillatory processes whose amplitude and frequency attenuate downstream V L

**A85-16531**

**A RANDOM CHOICE METHOD FOR TWO-DIMENSIONAL STEADY SUPERSONIC SHOCK WAVE DIFFRACTION PROBLEMS**

G MARSHALL and B PLOHR (New York University, New York, NY) Journal of Computational Physics (ISSN 0021-9991), vol. 56, Dec 1984, p 410-427 refs

(Contract DE-A027-76ER-03077, DAAG29-83-K-0007)

A random choice method for the numerical solution of steady, supersonic, two-dimensional plane and three-dimensional axisymmetric gas flows is presented The random choice method uses exact solutions of Riemann problems and sampling techniques. It is applicable to steady, supersonic flows in more than one dimension because these flows are described by a hyperbolic system of conservation laws in two independent variables. The method is applied to a variety of supersonic shock wave diffraction problems and compared to solutions obtained with the method of characteristics The main advantages of the method presented are its general applicability and its sharp resolution of discontinuities in the flow Author

**A85-16918**

**AN INTEGRAL APPROACH TO THE DETERMINATION OF THE ASYMPTOTIC BEHAVIOR OF SUPERSONIC FLOW [INTEGRAL'NYI PODKHOD K OPREDELENIU ASIMPTOTIKI SVERKHZVUKOVOGO OBTEKANIIA]**

V G DULOV, M S REZNIKOV, and A I RUDAKOV (Akademii Nauk SSSR, Institut Teoreticheskoi i Prikladnoi Mekhaniki, Novosibirsk, USSR) Akademii Nauk SSSR, Sibirskoe Otdelenie, Izvestiia, Seria Tekhnicheskikh Nauk (ISSN 0002-3434), Nov 1984, p 9-15 In Russian refs

An asymptotic flow pattern at large distances from a body traveling at supersonic velocity has been reported by Landau (1945)

and Whitham (1952) The analytical approach employed by Whitham (1952) for slender bodies cannot be used in the case of blunt bodies. A more suitable approach for the general case involves the establishment of a direct dependence between the integral characteristics of the source of the disturbance and the constants characterizing the asymptotic behavior The present investigation is, therefore, concerned with an analysis of the asymptotic flow at a distance from the body, taking into account a supersonic gas flow The area of the disturbed flow at a distance from the body is a comparatively narrow zone in the neighborhood of a bow shock wave The obtained results show that the utilization of the integral approach makes it possible to employ a procedure for the calculation of the asymptotic behavior of a flow under conditions involving supersonic velocities and blunt bodies G R

**A85-16919**

## THE PARAMETERS OF SHOCK WAVES FROM BODIES OF REVOLUTION IN A HOMOGENEOUS ATMOSPHERE [PARAMETRY UDARNYKH VOLN OT TEL VRASHCHENIIA V ODNORODNOI ATMOSFERE]

V F. CHIRKASHENKO and I U N IUDINTSEV (Akademiia Nauk SSSR, Institut Teoreticheskoi i Prikladnoi Mekhaniki, Novosibirsk, USSR) Akademiia Nauk SSSR, Sibirskoe Otdelenie, Izvestia, Seria Tekhnicheskikh Nauk (ISSN 0002-3434), Nov 1984, p. 16-21. In Russian. refs

The effect of the shape of a body of revolution on the parameters of shock waves generated by that body in supersonic flow is investigated by a method involving measuring excess static pressure profiles in the near region and converting them to large distances in accordance with quasi-linear theory In particular, attention is given to shock waves from bodies of revolution of power-law and modified power-law shapes In a class of low-aspect-ratio power-law bodies of revolution, bodies with minimum wave resistance are shown to generate bow shock waves of maximum intensity in the far zone. Modifying the shape of the nose section of a power-law body significantly reduces the intensity of the bow shock in the middle zone. V L

**A85-16939**

## EXACT SOLUTIONS OF SINGULAR EQUATIONS FOR VISCOUS TRANSONIC FLOWS [TOCHNYE RESHENIIA SINGULIARNYKH URAVNENII VIAZKIKH TRANZVUKOVYKH TECHENII]

IU. V. ZASORIN (Voronezhskii Gosudarstvennyi Universitet, Voronezh, USSR) Akademiia Nauk SSSR, Doklady (ISSN 0002-3264), vol 278, no. 6, 1984, p. 1347-1351 In Russian refs

**A85-17061**

## QUASISTATIC ANALYSIS OF COMPOSITE LIFTING SURFACES IN INCOMPRESSIBLE GAS FLOW [KVAZISTATICHESKII RASCHET SOSTAVNYKH NESUSHCHIKH POVERKHNOSTEI V POTOKE NESZHIMAEMOGO GAZA]

V A PAVLOV, V G. GAINUTDINOV, S A. MIKHAILOV, and V A PORTNOI Aviatsonnaia Tekhnika (ISSN 0579-2975), no 2, 1984, p 50-55 In Russian refs

A geometrically nonlinear procedure for the analysis of composite lifting surfaces of the fin-rudder type is proposed The aerodynamic characteristics are determined for each load increment using Belotserkovskii's (1965) method. Results are presented for a real wing with an aileron. V L

**A85-17066**

## CALCULATION OF THE AERODYNAMIC CHARACTERISTICS OF A WING [K RASCHETU AERODINAMICHESKIKH KHKHARAKTERISTIK KRYLA]

O P. SIDOROV Aviatsonnaia Tekhnika (ISSN 0579-2975), no. 2, 1984, p. 72-77 In Russian.

The study is concerned with flow of an ideal incompressible gas past a high-aspect-ratio wing with geometric and aerodynamic twist. The circulation over the wing span and the lifting force are determined, as are the induced drag and the rake angle. It is shown that the presence of a twist gives rise to an induced drag in the absence of a lifting force. V L

**A85-17075**

## DETERMINATION OF THE LIMITS OF THE STABILITY REGION OF A PARACHUTE SYSTEM WITH A LOW-PERMEABILITY CANOPY [K RASCHETU GRANITS OBLASTI USTOICHIVOSTI PARASHIUTNOI SISTEMY S KUPOLOM MALOI PRONITSIAEMOSTI]

V M CHURKIN and V N BARINOVA Aviatsonnaia Tekhnika (ISSN 0579-2975), no. 2, 1984, p 101-103 In Russian

In designing a parachute system with a low-permeability canopy, it is essential that permissible initial perturbations be estimated in addition to a standard linear stability analysis This problem is solved here using the method of harmonic linearization which makes it possible to determine the unstable cycle limiting the stability region of the steady motion of the parachute system in the initial perturbation space The approach proposed here is illustrated by an example V.L.

**A85-17243**

## OBLIQUE SHOCK WAVE - TURBULENT BOUNDARY LAYER INTERACTION WITH SUCTION

D B LEE (Korean Institute of Aeronautical Technology, Seoul, Republic of Korea, Poitiers, Universite, Poitiers, France) and R. LEBLANC (Poitiers, Universite, Poitiers, France) Aeronautical Journal (ISSN 0001-9240), vol. 88, Nov. 1984, p. 416-427 Sponsorship Direction des Recherches, Etudes et Techniques and Service Technique des Programmes Aeronautiques refs (Contract DRET-80-601, STPA-79,98508)

The interaction of an incident oblique shock wave with the turbulent boundary layer with suction is investigated Wall streamline and schlieren photograph visualisations as well as the pressure measurements on the wall are made Boundary layer surveys with pressure probes and hot-wire probes are also done The suction downstream of the interaction almost nullifies the shock reflection while the higher suction up and downstream of the interaction results in a reflection similar to that in inviscid flow Author

**A85-18066**

## COMPUTATION OF FLOW AROUND WINGS BASED ON THE EULER EQUATIONS

A. RIZZI and L-E. ERIKSSON (Flygtekniska Forsoksanstalten, Bromma, Sweden) Journal of Fluid Mechanics (ISSN 0022-1120), vol 148, Nov 1984, p 45-71 refs

Inviscid transonic flows containing either strong shock waves or complex vortex structure call for the Euler equations as a realistic model. A computational procedure WINGA2 for solving the Euler equations for transonic flow around aircraft upon a 0-0 mesh generated by transfinite interpolation is presented An explicit time-marching finite-volume technique solves the flow equations and features a nonreflecting far-field boundary condition and an internal mechanism for temporal damping together with a model for artificial viscosity The method's convergence to a steady state is studied, and results computed on the CYBER 205 vector processor are presented. The Euler equation model is found to predict the existence of a tip vortex created by flow separating from the downstream region of the tip of the ONERA M6 wing where the radius of curvature approaches zero Author

**A85-18281#**

## POTENTIAL EQUATION FOR TRANSONIC STEADY FLOW WITH LARGE LONGITUDINAL DISTURBANCE AND LINE RELAXATION

S LUO Northwestern Polytechnical University, Journal, vol. 2, Oct. 1984, p 421-427. In Chinese, with abstract in English. refs

The potential equation for large longitudinal disturbances and small transverse disturbances is discussed and some numerical examples of transonic flows around an airfoil with a blunt leading edge and an inlet with a central body are presented The stability and convergence analyses of the linearized line-relaxed difference and differential equations are addressed. A Fourier analysis of the line relaxation error is made and it is found that at both subsonic and supersonic points, the relaxation can suppress the high-frequency components of error quite rapidly but low-frequency components only slowly. Changing the relaxation factor with omega

between zero and two during the Seidel iterative process can speed up the suppression. The relaxation direction normal to the boundary provides a faster speed of convergence. C D

#### A85-18282#

##### THE HOPSCOTCH FINITE VOLUME METHOD FOR SOLVING THE EULER EQUATIONS

S LIU and C WU Northwestern Polytechnical University, Journal, vol 2, Oct 1984, p 429-437. In Chinese, with abstract in English.

In order to study the effectiveness and accuracy of the hopscotch scheme for computing multidimensional flow problems, the scheme is applied to a finite volume of flow and developed into a hopscotch finite volume method. The method is used to calculate several transonic and high subsonic flows, and the results show that the accuracy of the method is satisfactory and its computing speed twice that of other popular explicit schemes. Comparisons are made between the exact solution of a one-dimensional flow and the results obtained by the hopscotch scheme and another explicit scheme. For both shock-free and shocked flow, the agreement is satisfactory. The time steps and CPU times required for convergence of the hopscotch and McCormack schemes are also compared. C D

#### A85-18286#

##### DATA ACQUISITION AND PROCESSING FOR STEADY-STATE INLET PRESSURE DISTORTION AT A TURBOJET ENGINE FACE

B LU, Y WU, N ZHANG, Y SUEN, and Y XA Northwestern Polytechnical University, Journal, vol 2, Oct 1984, p 473-478. In Chinese, with abstract in English.

This paper describes the problem and technique for on-line real time processing of steady-state inlet pressure distortion parameters at a turbojet engine face using the data acquisition and processing system of the 622 computer. When testing steady-state pressure distortion of turbojet engine, about 400 parameters need to be acquired. In computation and processing, there are about 800 out-put parameters. All programs for testing and processing are programmed in assembly language. By on-line experimenting with an engine, it is proved that both the data acquisition accuracy and the results computed by this system can satisfy the requirements of engine testing. Thus, automatic data acquisition and processing for steady-state inlet pressure distortion of turbojet engine is achieved. Author

#### A85-18434#

##### NEW TRICKS FOR CUTTING DRAG

R DEMEIS Aerospace America (ISSN 0740-722X), vol 23, Jan 1985, p. 75, 76, 78.

Drag is produced by large wingtip vortices, the slightly aft-directed lift forces, and the downwash forces induced on the wing by the vortices. Increasing the wingspan attenuates the downwash over a greater lifting area, orients the lift vector more vertically, and moves the wingtip vortices further from the inboard wing sections. Winglets can generate some lift at the tip and wingtip propellers rotating opposite to the vortices could increase lift by 10 percent, although a weight penalty is to be expected from the additional machinery. Engine bleed air jets can be directed spanwise from the tips and reduce the required engine power by 25 percent by dispersing the tip vortices. Wingtip sails, an analog to bird wingtip feathers, are also being investigated for dispersing tip vortex strength. Aft-mounted propellers and integrated propulsion devices have been found to eliminate the engine turbulence washing over the fuselage and to reduce wake drag, offering a potential 50 percent power savings. M S.K

#### A85-18506#

##### AERODYNAMIC CHARACTERISTICS OF AN AIRFOIL IN A NONUNIFORM WIND PROFILE

F M. PAYNE and R C NELSON (Notre Dame, University, Notre Dame, IN) Journal of Aircraft (ISSN 0021-8669), vol 22, Jan 1985, p 5-10. Research supported by the University of Notre Dame, U.S. Department of Transportation. Previously cited in issue 6, p 798, Accession no. A82-17843 refs (Contract DOT-RC-82010)

#### A85-18507#

##### UNSTEADY RESPONSE OF AN AXIAL FLOW COMPRESSOR TO PLANAR TEMPERATURE TRANSIENTS

D K DAS (New York, State University, Utica, NY), R E PEACOCK (U S Naval Postgraduate School, Monterey, CA), and A TRIPPI Journal of Aircraft (ISSN 0021-8669), vol 22, Jan. 1985, p 11-18. Previously cited in issue 17, p 2675, Accession no A82-35093 refs

#### A85-18508#

##### COMPRESSIBLE LIFTING SURFACE THEORY FOR PROPELLER PERFORMANCE CALCULATION

D B HANSON (United Technologies Corp., Hamilton Standard Div., Windsor Locks, CT) Journal of Aircraft (ISSN 0021-8669), vol. 22, Jan 1985, p 19-27. refs

A new integral equation for propeller steady aerodynamic analysis is presented that generalizes wing kernel function methods to include effects of rotation and multiple blades. The kernel of the integral equation is valid in a single form for the case, typical of propfans (advanced technology, many bladed propellers which operate at high cruise Mach number), where the blade section relative speeds are subsonic at the roots and supersonic at the tips. Within the restrictions of linearized theory, effects of blade interference, sweep, three dimensionality, and compressibility are rigorously accounted for. Behavior of the kernel is studied and compared with well-known results from wing and propeller wake theories. Methods for inverting the integral equation to compute lift distribution and for determining vortex (or induced) drag are adapted from wing theory. Computed efficiency, power, and spanwise power distribution are in excellent agreement with data for a propfan model with swept blades tested at 0.8 cruise Mach number in a NASA wind tunnel. Author

#### A85-18509#

##### STEADY AND UNSTEADY TRANSONIC AIRLOADS ON A SUPERCRITICAL WING

S Y RUO, J B MALONE (Lockheed-Georgia Co., Marietta, GA), J J HORSTEN, and R HOUWINK (Nationaal Lucht- en Ruimtevaartlaboratorium, Amsterdam, Netherlands) Journal of Aircraft (ISSN 0021-8669), vol. 22, Jan 1985, p 28-36. Previously cited in issue 18, p. 2632, Accession no A83-39099 refs (Contract F33615-80-C-3212, AF-AFOSR-80-0136)

#### A85-18510#

##### EFFECTS OF SUCTION ON SHOCK/BOUNDARY-LAYER INTERACTION AND SHOCK-INDUCED SEPARATION

P KROGMANN, E STANEWSKY (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Institut fuer experimentelle Stromungsmechanik, Goettingen, West Germany), and P. THIEDE (Messerschmitt-Boelkow-Blohm GmbH, West Germany) Journal of Aircraft (ISSN 0021-8669), vol 22, Jan 1985, p 37-42. Previously cited in issue 6, p. 704, Accession no A84-17880 refs

## 02 AERODYNAMICS

**A85-18511\*#** Virginia Polytechnic Inst. and State Univ., Blacksburg

### **A VORTEX-LATTICE METHOD FOR GENERAL, UNSTEADY AERODYNAMICS**

P. KONSTADINOPOULOS, D. F. THRASHER, D. T. MOOK, A. H. NAYFEH, and L. WATSON (Virginia Polytechnic Institute and State University, Blacksburg, VA) *Journal of Aircraft* (ISSN 0021-8669), vol 22, Jan. 1985, p. 43-49 refs  
(Contract N00014-79-C-0103, NSG-1262)

A general method of calculating unsteady, incompressible, inviscid, three-dimensional flows around arbitrary planforms has been developed. The method is an extension of the vortex-lattice technique. It is not limited by aspect ratio, camber, or angle of attack, as long as vortex breakdown does not occur above the surface of the wing and separation occurs only along sharp edges. As the wing performs arbitrary maneuvers, the position of the wake and the distribution of circulation on the wing and in the wake are obtained as functions of time. One desirable feature of the present method is its ability to treat steady lifting flows very efficiently. Several examples of steady and unsteady flows are presented. These include rectangular wings, with and without flaps, delta, and cropped delta wings. Author

**A85-18512\*#** National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

### **TRANSONIC SOLUTIONS FOR A MULTIELEMENT AIRFOIL USING THE FULL-POTENTIAL EQUATIONS**

J. FLORES, T. L. HOLST, and R. L. SORENSON (NASA, Ames Research Center, Moffett Field, CA) *Journal of Aircraft* (ISSN 0021-8669), vol. 22, Jan. 1985, p. 50-56. Previously cited in issue 6, p. 708, Accession no. A84-18007 refs

**A85-18515\*#** National Aeronautics and Space Administration, Langley Research Center, Hampton, Va

### **THE INFLUENCE OF LEADING-EDGE LOAD ALLEVIATION ON SUPERSONIC WING DESIGN**

C. M. DARDEN (NASA, Langley Research Center, High-Speed Aerodynamics Div., Hampton, VA) *Journal of Aircraft* (ISSN 0021-8669), vol 22, Jan 1985, p. 71-77. Previously cited in issue 6, p. 705, Accession no. A84-17906. refs

**A85-18516#**

### **FLOW OVER DOUBLE-DELTA WING AND WING BODY AT HIGH ALPHA**

D. MANOR (Parks College, Cahokia, IL) and W. H. WENTZ, JR. (Wichita State University, Wichita, KS) *Journal of Aircraft* (ISSN 0021-8669), vol 22, Jan. 1985, p. 78-82 refs

The effects of sideslip on the performance and stability of a double-delta wing and wing-body configuration were determined experimentally. The wake total pressure reveals the vortex size, location, and shape. Sideslip angle resulted in a decreased stall angle of attack, lower maximum coefficient of lift, enhancement of post-stall lift recovery, increased upwind vortex sheet size, and decreased downwind vortex size. Adding the body to the wing increased the levels of adverse rolling and yawing moments at the stall. The wake surveys show that a narrow band at the edge of the vortex sheet has a very steep total pressure gradient present in all configurations. Author

**A85-18517#**

### **THE AERODYNAMIC BEHAVIOR OF INFINITE SWEEPED WINGS - ANOTHER POINT OF VIEW**

A. ROSEN and O. RAND (Technion - Israel Institute of Technology, Haifa, Israel) *Journal of Aircraft* (ISSN 0021-8669), vol 22, Jan. 1985, p. 83-85

In current treatments of the aerodynamic behavior of infinite swept wings in incompressible flow, the lift curve slope of cross sections parallel to the freestream direction is reduced by a factor equal to the cosine of the sweep angle. There is, however, no convincing physical explanation for this effect that is an inherent property of the two-dimensional profile. According to the present view of this behavior, the reduction of lift/unit length is due to a

reduction of the effective angle-of-attack of each cross section  
O C

**A85-18519#**

### **ROLL UP OF STRAKE LEADING/TRAILING-EDGE VORTEX SHEETS FOR DOUBLE-DELTA WINGS**

Y. XIEYMAN (University of Science and Technology of China, Hefei, People's Republic of China, Connecticut, University, Storrs, CT) *Journal of Aircraft* (ISSN 0021-8669), vol 22, Jan 1985, p. 87-89. refs

An examination is undertaken of the ability of a simple, two-dimensional point vortex method to simulate the roll-up of complex, strake leading/trailing edge vortex sheets. The effect of the interaction of such vortex sheets on the downwash field is also considered. Vortex strength is determined by means of a leading edge suction analogy as well as vortex-impulse theorem. O C

**A85-18521#**

### **COMMENT ON 'PREDICTION OF SUBSONIC AERODYNAMIC CHARACTERISTICS - A CASE FOR LOW-ORDER PANEL METHODS'**

G. G. GROH (California, University, Berkeley, CA) *Journal of Aircraft* (ISSN 0021-8669), vol 22, Jan 1985, p. 92, 93.  
(Contract DE-AC03-76SF-00098)

**A85-18522#**

### **COMMENT ON 'EFFECTS OF ATMOSPHERIC TURBULENCE ON A QUADROTOR HEAVY-LIFT AIRSHIP'**

B. ETKIN *Journal of Aircraft* (ISSN 0021-8669), vol. 22, Jan 1985, p. 93-95 refs

**A85-18527#**

### **STUDY OF DELTA WING CHARACTERISTICS AS A FAN BLADE MODEL. I. VISUALIZATION OF THREE-DIMENSIONAL FLOW BY SMOKE WIRE METHOD**

H. FUJITA, Y. TAKADA, and S. SATOH (Hitachi, Ltd., Mechanical Engineering Research Laboratory, Tsuchiura, Ibaraki, Japan) *JSME, Bulletin* (ISSN 0021-3764), vol 27, Oct. 1984, p. 2107-2112 refs

The flow around a flat delta wing is investigated in order to establish a technique of visualization of a three-dimensional flow by a smoke-wire method. Applications to the study of steady and nonsteady responses of single and cascades of delta wings are also considered. It is found that the structure of the leading-edge vortices (with particular reference to the breakdown of the vortex core over the wing surface) as well as the structure of the free vortex zone can be investigated in detail by choosing proper combinations of relative attitudes and locations between the wing and the smoke wire and taking photographs from three perpendicular directions. Author

**A85-18528#**

### **EXACT SOLUTION OF COMPRESSIBLE POTENTIAL FLOW PAST A BODY OF REVOLUTION AT ZERO INCIDENCE - ESPECIALLY FOR HIGH SUBSONIC FLOW**

T. MIYAZAKI (Kokushikan University, Tokyo, Japan) and N. HIRAYAMA (Tokyo Metropolitan University, Tokyo, Japan) *JSME, Bulletin* (ISSN 0021-3764), vol. 27, Oct 1984, p. 2113-2117

A new solution is shown for a compressible potential flow past an arbitrary body of revolution at zero incidence, with reference to flows in turbomachines and past aircraft. A complex velocity for the flow is solved exactly through an integral equation obtained through pseudo-analytic function theories. The method may be applied to many compressible flow problems and with a few supplemental arguments, may be used to solve inverse problems. Numerical illustrations of the method, which depends on correspondence between an incompressible two-dimensional and a compressible axially symmetric potential flow, are given for subsonic flows past ellipsoids, and results show agreement between computed and measured values. M.D.

A85-18676#

**CONICAL FLOW NEAR EXTERNAL AXIAL CORNERS AS A BIFURCATION PROBLEM**

P G BAKKER and J. W. REYN (Delft, Technische Hogeschool, Delft, Netherlands) AIAA Journal (ISSN 0001-1452), vol 23, Jan 1985, p 4-11 refs

The supersonic flow around configurations consisting of two plane delta wings, attached to each other along a common edge, forming an external corner is discussed on the basis of potential conical flow theory. The occurrence and character of conical stagnation points are studied as a bifurcation from the starlike node in the conical streamline pattern, which occurs at the corner point in a uniform flow. Various bifurcation modes are possible, including those where nodal points move away from the corner on which a saddle point is formed. As an example, the flow around a symmetrical external corner is discussed to illustrate the use of the first bifurcation mode to obtain a better understanding of the flowfield. As a result, the flow pattern with a saddle point at the corner flanked by two modal points on the body surface is confirmed. Comparison is made with numerical calculations and experimental results. Author

A85-18677#

**VISCOUS/INVISCID ANALYSIS OF CURVED SUB- OR SUPERSONIC WALL JETS**

S M DASH, R. A. BEDDINI, D E WOLF, and N SINHA (Science Applications, Inc., Propulsion Gas Dynamics Div., Princeton, NJ) AIAA Journal (ISSN 0001-1452), vol 23, Jan. 1985, p 12, 13. Abridged. Previously cited in issue 17, p 2452, Accession no A83-38086 refs (Contract N00167-81-C-0180)

A85-18678#

**APPROXIMATE FACTORIZATION SCHEMES FOR THREE-DIMENSIONAL NONLINEAR SUPERSONIC POTENTIAL FLOW**

M J SICLARI (Grumman Aerospace Research and Development Center, Bethpage, NY) AIAA Journal (ISSN 0001-1452), vol 23, Jan 1985, p 14-22. Previously cited in issue 05, p 591, Accession no A83-17923 refs

**A85-18679\*# National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio**  
**EFFICIENT SOLUTION OF THE EULER AND NAVIER-STOKES EQUATIONS WITH A VECTORIZED MULTIPLE-GRID ALGORITHM**

R C CHIMA (NASA, Lewis Research Center, Cleveland, OH) and G. M. JOHNSON (Colorado State University, Fort Collins, CO) (Computational Fluid Dynamics Conference, 6th, Danvers, MA, July 13-15, 1983, Collection of Technical Papers, p. 72-89) AIAA Journal (ISSN 0001-1452), vol. 23, Jan 1985, p. 23-32. Previously cited in issue 18, p. 2634, Accession no A83-39359 refs

A85-18681\*# Rockwell International Science Center, Thousand Oaks, Calif

**TREATMENT OF SUPERSONIC FLOWS WITH EMBEDDED SUBSONIC REGIONS**

V SHANKAR, K.-Y. SZEMA (Rockwell International Science Center, Thousand Oaks, CA), and S. OSHER (California, University, Los Angeles, CA) (Computational Fluid Dynamics Conference, 6th, Danvers, MA, July 13-15, 1983, Collection of Technical Papers, p. 36-47) AIAA Journal (ISSN 0001-1452), vol 23, Jan 1985, p. 41-48. Previously cited in issue 18, p. 2634, Accession no. A83-39356 refs (Contract NAS1-15820)

A85-18683#

**BOUNDARY LAYERS AND SEPARATION ON A SPHEROID AT INCIDENCE**

V C PATEL and J. H. BAEK (Iowa, University, Iowa City, IA) (Symposium on Numerical and Physical Aspects of Aerodynamic Flows, 2nd, Long Beach, CA, January 17-20, 1983, p. 13) AIAA Journal (ISSN 0001-1452), vol 23, Jan 1985, p. 55-63. Army-supported research. Previously cited in issue 01, p. 5, Accession no A84-10109 refs (Contract AF-AFOSR-80-0148-B)

A85-18697\*# Science Applications, Inc., Princeton, N.J

**NONITERATIVE CROSS-FLOW INTEGRATION FOR THE PRESSURE-SPLIT ANALYSIS OF SUBSONIC MIXING-LAYER PROBLEMS**

S. M. DASH and N SINHA (Science Applications, Inc., Propulsion Gas Dynamics Div., Princeton, NJ) AIAA Journal (ISSN 0001-1452), vol 23, Jan. 1985, p. 153-155 refs (Contract N00167-83-C-0082, NAS1-16535)

In utilizing pressure-split methodology for the two-dimensional analysis of curved wall jets and the subsonic regions of underexpanded free jets, Dash et al (1984) employed the cross flow procedure of Bradshaw et al (1979, 1984). In assessing this procedure, it was noted that the iterative steps required between the continuity and cross flow momentum equation solutions could be eliminated by combining these equations into a unified equation for the cross flow velocity, yielding a significant reduction in computer time and eliminating possible convergence problems which occur in iterative approaches. Attention is presently given to the application of this noniterative procedure to a two-dimensional curved wall jet problem. O C

A85-18698\*# National Aeronautics and Space Administration Langley Research Center, Hampton, Va

**EMMONS SPOT FORCING FOR TURBULENT DRAG REDUCTION**

W L GOODMAN (NASA, Langley Research Center, High-Speed Aerodynamics Div., Hampton, VA) AIAA Journal (ISSN 0001-1452), vol. 23, Jan 1985, p. 155-157 refs

An Emmons spot-generation wind tunnel system has been designed to trigger closely spaced Emmons spots in the spanwise and longitudinal directions of an aerodynamic surface. For certain combinations of generator frequencies and amplitude, hole size, and hole spacing, experimental results indicate smaller turbulence scales and a reduction in skin friction of about 15 percent. O C.

N85-13767 Tennessee Univ., Knoxville

**A STUDY OF LIFT CHARACTERISTICS OF AN UPPER SURFACE BLOWN JETWING WITH A RECTANGULAR NOZZLE Ph.D. Thesis**A. K SINHA 1984 144 p  
Avail. Univ. Microfilms Order No DA8421406

The lift characteristics of an upper surface blown (USB) jet-flapped aircraft with rectangular nozzle were studied. An empirical criterion was used to replace the jet sheet leaving the trailing edge with an equivalent mechanical flap extension. Lifting line analysis was used to obtain the spanwise load and induced angle of attack distribution. Additional supercirculation, because of the presence of a high energy jet on the wing upper surface, was obtained from momentum considerations. The predicted values of lift and pitching moment coefficient ( $C_L$  and  $C_M$ ) were compared with full scale wind tunnel and flight test data on the Ball-Bartoe JETWING USB aircraft and show good agreement in  $C_L$ . The semi-empirical model developed can handle a part scale flap with variable jet momentum distribution and chordwise location of the nozzle. This simple method is considered to be a valuable tool for the preliminary design of an USB aircraft with a rectangular nozzle. Dissert Abstr



## 02 AERODYNAMICS

**N85-13768** Stanford Univ., Calif.  
**SIMULATION OF SEPARATED TRANSONIC AIRFOIL FLOW BY FINITE-DIFFERENCE VISCOUS-INVISCID INTERACTION Ph.D. Thesis**

W R. VANDALSEM 1984 118 p  
Avail: Univ. Microfilms Order No. DA8420630

A finite-difference viscous-inviscid interaction program was developed which is capable of simulating the separated transonic flow about non-lifting and lifting airfoils. This code consists of direct-inverse, finite-difference boundary layer algorithm coupled with a transonic full-potential airfoil program using viscous-inviscid interaction algorithms. The accuracy and efficiency of the developed viscous and viscous-inviscid interaction programs was tested and verified by comparison with theory, the results of other boundary-layer and Navier-Stokes computations, and experimental data. Separated transonic flow fields about lifting airfoils are accurately simulated for approximately 1 to 5% of the cost of a Navier-Stokes simulation of equal resolution. Because efficient viscous and inviscid algorithms are used and the viscous-inviscid interaction convergences rapidly, it is expected the code will also compare favorably with other codes of its type as they become available. Dissert Abstr

**N85-13770** Stanford Univ., Calif.  
**THE NUMERICAL SIMULATION OF STEADY TRANSONIC ROTATIONAL FLOW USING A DUAL POTENTIAL FORMULATION Ph.D. Thesis**

N M CHADERJIAN 1984 169 p  
Avail: Univ. Microfilms Order No. DA8420503

Two finite difference methods were developed to numerically simulate steady transonic rotational flow of an inviscid fluid by representing the velocity field as the sum of scalar and vector potentials. The resulting dual potential equations are efficiently solved as iteratively decoupled scalar equations. Moreover, an alternate treatment of lifting airfoil flow is presented that avoids the use of circulation wake cuts by specifying the vector potential as a constant on the airfoil surface. The zonal method has been verified on a nonlifting biconvex airfoil while the entropy correction method has been verified on both nonlifting and lifting airfoils. The entropy correction method is more efficient than the zonal method, and an optimized/vectorized entropy correction code should be able to obtain rotational solutions in about three seconds of Cray-XMP time. Dissert Abstr

**N85-13773** Ohio State Univ., Columbus  
**EXPERIMENTAL STUDIES OF TRANSONIC AIRFOIL TRAILING EDGE AND WAKE FLOWFIELD PROPERTIES Ph.D. Thesis**

D. S. EMMER 1984 226 p  
Avail: Univ. Microfilms Order No. DA8418937

An experimental investigation of several of the trailing edge and wake turbulence properties for a NACA 84A010 airfoil section was completed. The experiment was conducted at The Ohio State University Aeronautical and Astronautical Research Laboratory in the 6 inch x 22 inch transonic flow facility. For both angles of attack, the turbulence intensities and turbulence kinetic energy were observed to decay in the streamwise direction. In the fair wake, the turbulence intensities were nearly isotropic for the nonlifting case. For the two degree case, the horizontal component of the turbulence intensity was observed to be substantially higher than the vertical component. For each survey, the data demonstrated excellent repeatability with a high degree of spatial resolution. The results of this research should provide guidance for the development, verification, and improvement of turbulence modeling. Dissert Abstr

**N85-13776\*#** Nielsen Engineering and Research, Inc., Mountain View, Calif

**COMPUTER PROGRAMS TO PREDICT INDUCED EFFECTS OF JETS EXHAUSTING INTO A CROSSFLOW**

S. C. PERKINS, JR. and M. R. MENDENHALL Jun 1984 157 p refs  
(NASA-CR-166591, NAS 1 26:166591, NEAR-TR-328) Avail NTIS HC A08/MF A01 CSDL 01A

A user's manual for two computer programs was developed to predict the induced effects of jets exhausting into a crossflow. Program JETPLT predicts pressures induced on an infinite flat plate by a jet exhausting at angles to the plate and Program JETBOD, in conjunction with a panel code, predicts pressures induced on a body of revolution by a jet exhausting normal to the surface. Both codes use a potential model of the jet and adjacent surface with empirical corrections for the viscous or nonpotential effects. This program manual contains a description of the use of both programs, instructions for preparation of input, descriptions of the output, limitations of the codes, and sample cases. In addition, procedures to extend both codes to include additional empirical correlations are described. Author

**N85-13777\*#** National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif

**AN EXPERIMENTAL INVESTIGATION OF THE PARALLEL BLADE-VORTEX INTERACTION**

F. X. CARADONNA, G. H. LAUB, and C. TUNG Nov 1984 33 p refs  
(NASA-TM-86005, A-9850, NAS 1 15 86005, USAVSCOM-TM-84-A-9) Avail. NTIS HC A03/MF A01 CSDL 01A

A scheme for investigating the parallel blade vortex interaction (BVI) has been designed and tested. The scheme involves setting a vortex generator upstream of a nonlifting rotor so that the vortex interacts with the blade at the forward azimuth. The method has revealed two propagation mechanisms: a type C shock propagation from the leading edge induced by the vortex at high tip speeds, and a rapid but continuous pressure pulse associated with the proximity of the vortex to the leading edge. The latter is thought to be the more important source. The effects of Mach number and vortex proximity are discussed. Author

**N85-13787#** Eidgenossisches Flugzeugwerk, Emmen (Switzerland) Versuchs- und Forschungsanlage

**FLOW CALCULATION ON A THIN WING, WITH SPECIFIC ATTENTION TO SEPARATION POINT AT THE TRAILING EDGE [STROMUNGSBEREICH UM SCHLANKEN FLUEGEL UNTER BERUECKSICHTIGUNG DER STROMUNGSABLOESUNG AN DER SEITENKANTE]**

M. SCHLEICHER 16 Apr 1984 33 p refs In GERMAN (FTW-FO-1721) Avail NTIS HC A03/MF A01

A three dimensional computation method for subsonic flows was expanded to cope with nonlinear effects inducing separation point on the trailing edge. The calculation was made on rectangular and triangular plates and shows the lift distribution over the wing span and the trailing vortex generated. The method provides good results concerning rectangular and trapezoidal wings while for delta wings numerical difficulties occur. Nevertheless in that case, results are as precise as far more expensive methods. It describes correctly the external flow, and a flap angle can be introduced in the data. Author (ESA)

**N85-14656#** Joint Publications Research Service, Arlington, Va.  
**PROPULSIVE EFFICIENCY OF VIBRATING WING IN SUPERSONIC FLOW Abstract Only**

M. N. KOGAN and M. V. USTINOV In its USSR Rept: Phys and Math. (JPRS-UPM-84-007) p 19 18 Oct. 1984 Transl. into ENGLISH from Zh. Eksp. Teor. Fiz. (Moscow), no. 2, Mar. - Apr. 1984 p 132-139 Original language document announced as A84-35736 Avail NTIS HC A06

It is shown that the problem of determining the shape of a wing with minimum resistance for a given lifting force can be

solved for a vibrating wing by expressing the working force and resistance through the circulation distribution along the wing, finding the optimum circulation distribution and its corresponding minimum resistance and then finding the wing shape (for subsonic velocities); for supersonic velocities the resistance and lifting force can be expressed for the potential on the traveling characteristic surface, and then the wing shape derived. The minimum power required to obtain given lifting force and thrust is determined, and the maximum power received by a wing from a flow for a given resistance is found. The solution is sought within the framework of the linear theory of supersonic flows. The resistance which must be overcome in order to obtain some power is always greater than the amount of thrust which can be obtained with the help of that power. Author

**N85-14796\*#** Stanford Univ, Calif Joint Inst for Aeronautics and Acoustics

**AN EXPERIMENTAL STUDY OF AIRFOIL-SPOILER AERODYNAMICS**

B G MCLACHLAN and K KARAMCHETI Feb 1985 88 p refs

(Contract NCC2-74)

(NASA-CR-177328, NAS 1 26.177328, SU-JIAA-TR-52) Avail NTIS HC A05/MF A01 CSCL 01A

The steady/unsteady flow field generated by a typical two dimensional airfoil with a statically deflected flap type spoiler was investigated. Subsonic wind tunnel tests were made over a range of parameters: spoiler deflection, angle of attack, and two Reynolds numbers, and comprehensive measurements of the mean and fluctuating surface pressures, velocities in the boundary layer, and velocities in the wake. Schlieren flow visualization of the near wake structure was performed. The mean lift, moment, and surface pressure characteristics are in agreement with previous investigations of spoiler aerodynamics. At large spoiler deflections, boundary layer character affects the static pressure distribution in the spoiler hingeline region, and, the wake mean velocity fields reveals a closed region of reversed flow aft of the spoiler. It is shown that the unsteady flow field characteristics are as follows: (1) the unsteady nature of the wake is characterized by vortex shedding, (2) the character of the vortex shedding changes with spoiler deflection, (3) the vortex shedding characteristics are in agreement with other bluff body investigations, and (4) the vortex shedding frequency component of the fluctuating surface pressure field is of appreciable magnitude at large spoiler deflections. The flow past an airfoil with deflected spoiler is a particular problem in bluff body aerodynamics is considered. E A K

**N85-14797\*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va

**STATIC INTERNAL PERFORMANCE OF SINGLE-EXPANSION-RAMP NOZZLES WITH VARIOUS COMBINATIONS OF INTERNAL GEOMETRIC PARAMETERS**

R J RE and L D LEAVITT Dec 1984 81 p refs

(NASA-TM-86270, L-15814, NAS 1.15 86270) Avail NTIS HC A05/MF A01 CSCL 01A

The effects of five geometric design parameters on the internal performance of single-expansion-ramp nozzles were investigated at nozzle pressure ratios up to 10 in the static-test facility of the Langley 16-Foot Transonic Tunnel. The geometric variables on the expansion-ramp surface of the upper flap consisted of ramp chordal angle, ramp length, and initial ramp angle. On the lower flap, the geometric variables consisted of flap angle and flap length. Both internal performance and static-pressure distributions on the centerlines of the upper and lower flaps were obtained for all 43 nozzle configurations tested. Author

**N85-14798\*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

**A THREE-DIMENSIONAL AXISYMMETRIC CALCULATION PROCEDURE FOR TURBULENT FLOWS IN A RADIAL VANELESS DIFFUSER**

L F SCHUMANN 1984 17 p refs. Proposed for presentation at the 30th Intern Gas Turbine Conf and Exhibit, Houston, Tex, 17-21 Mar 1985, sponsored by the American Society of Mechanical Engineers

(NASA-TM-86903, E-2387, NAS 1 15 86903, USAAVSCOM-TR-84-C-21) Avail NTIS HC A02/MF A01 CSCL 01A

An analytical model is proposed to calculate the three-dimensional axisymmetric turbulent flowfield in a radial vaneless diffuser. The model assumes that the radial and tangential boundary layer profiles are approximated by power law profiles. Then, using the integrated radial and tangential momentum and continuity equations for the boundary layer and corresponding inviscid equations for the core flow, there results six ordinary differential equations in six unknowns which are easily solved using a Runge-Kutta technique. A model is also proposed for fully developed flow. The results using this technique were compared with the results from a three-dimensional viscous, axisymmetric duct code and with experimental data and good quantitative agreement was obtained. Author

**N85-14799\*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va

**COMPARISON OF UNIFORM PERTURBATION SOLUTIONS AND NUMERICAL SOLUTIONS FOR SOME POTENTIAL FLOWS PAST SLENDER BODIES Final Report**

T C WONG (George Washington Univ, Washington, D C), C H LIU, and J GEER (State Univ of New York, Binghamton) Oct 1984 34 p refs

(Contract NAS1-17070, NAS1-14605) (NASA-CR-172485, ICASE-84-56, NAS 1 26 172485) Avail NTIS HC A03/MF A01 CSCL 01A

Approximate solutions for potential flow past an axisymmetric slender body and past a thin airfoil are calculated using a uniform perturbation method and then compared with either the exact analytical solution or the solution obtained using a purely numerical method. The perturbation method is based upon a representation of the disturbance flow as the superposition of singularities distributed entirely within the body, while the numerical (panel) method is based upon a distribution of singularities on the surface of the body. It is found that the perturbation method provides very good results for small values of the slenderness ratio and for small angles of attack. Moreover, for comparable accuracy, the perturbation method is simpler to implement, requires less computer memory, and generally uses less computation time than the panel method. In particular, the uniform perturbation method yields good resolution near the regions of the leading and trailing edges where other methods fail or require special attention. Author

**N85-14801#** National Aerospace Lab, Tokyo (Japan)

**DEVELOPMENT OF THE CODE NSFOIL FOR ANALYZING HIGH REYNOLDS NUMBER TRANSONIC FLOW AROUND AN AIRFOIL**

N KAWAI and N HIROSE Jun 1984 29 p refs In JAPANESE, ENGLISH summary

(NAL-TR-816; ISSN-0389-4010) Avail NTIS HC A03/MF A01

A computer code, called NSFOIL, has been developed for analyzing high Reynolds number transonic flow around an airfoil. The implicit approximate factorization scheme for the Navier-Stokes equations with an algebraic eddy viscosity model of the turbulent boundary layer is used with the implicit boundary condition on the airfoil and the wake cut boundary. The present code contains various option parameters for physical models, and I/O forms, i.e., full or thin layer approximate NS equations, fully turbulent or transition models of boundary layer, etc. Emphasis is put on the various output forms of the computed results to provide aerodynamics designers with full information on aerodynamic,

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boundary layer and wake characteristics including shock-induced separation and trailing edge separation phenomena. Some of the computed results are presented and compared with the wind tunnel experiment results. In the appendix, the operation manual of the code is described. Author

**N85-14802\*#** Analytical Methods, Inc., Bellevue, Wash.  
**PROGRAM VSAERO: A COMPUTER PROGRAM FOR CALCULATING THE NON-LINEAR AERODYNAMIC CHARACTERISTICS OF ARBITRARY CONFIGURATIONS: USER'S MANUAL**

B MASKEW Dec. 1982 176 p  
(Contract NAS2-8788)  
(NASA-CR-166476, NAS 1 26 166476) Avail: NTIS HC A09/MF A01 CSCL 01A

VSAERO is a computer program used to predict the nonlinear aerodynamic characteristics of arbitrary three-dimensional configurations in subsonic flow. Nonlinear effects of vortex separation and vortex surface interaction are treated in an iterative wake-shape calculation procedure, while the effects of viscosity are treated in an iterative loop coupling potential-flow and integral boundary-layer calculations. The program employs a surface singularity panel method using quadrilateral panels on which doublet and source singularities are distributed in a piecewise constant form. This user's manual provides a brief overview of the mathematical model, instructions for configuration modeling and a description of the input and output data. A listing of a sample case is included. Author

**N85-14974#** Joint Publications Research Service, Arlington, Va.  
**AERODYNAMIC AND THERMAL CHARACTERISTICS OF STELLATE BODIES IN HYPERSONIC FLOW OF RAREFIED GAS AT ANGLE OF ATTACK Abstract Only**

A I BUNIMOVICH and V I KUZMENKO *In its* USSR Rept. Eng. and Equipment (JPRS-UEQ-84-007) p 39 14 Nov 1984 Transl. into ENGLISH from Vestn. Mosk Univ. Ser 1: Mat., Mekhan. (Moscow), no. 2, Mar-Apr 1984 p 74-77  
Avail: NTIS HC A04/MF A01

The aerodynamic and thermal characteristics of stellate bodies are assessed for varying members of rays, relative thickness, flight altitude and angle of attack. Graphs are developed that can be used to select the optimum configuration for a specific problem. R J F.

**N85-14979#** Joint Publications Research Service, Arlington, Va.  
**HYPERSONIC FLOW OF MIXTURE AROUND BLUNT BODY Abstract Only**

A. Y. SAGOMONYAN *In its* USSR Rept. Eng. and Equipment (JPRS-UEQ-84-007) p 43 14 Nov 1984 Transl. into ENGLISH from Vestn. Mosk Univ., Ser 1: Mat. i Mekhan. (Moscow), no. 3, May-Jun. 1984 p 54-62  
Avail: NTIS HC A04/MF A01

Hypersonic flow of a mixture around a blunt body is treated in the irrotational approximation, by extending the Lighthill method of solution for a homogeneous incompressible fluid behind the shock wave front to a compressible two-phase mixture. A symmetric body such as a sphere is considered in an original velocity of sound. The mixture is a thermodynamically ideal gas containing solid particles or liquid drops in suspension. The corresponding two dimensional equations of motion for this centrifymmetric problem are formulated in a polar system of coordinates with the origin at the center of the sphere and with the equation of state of the suspended phase given, disregarding any phases transformation of the suspended substance such as evaporation of liquid in the wave. These equations are solved for distributions of tangential and radial velocity and gas pressure and particle concentration in and behind the wave, with appropriate boundary conditions stipulated at the surface. The pressure of the mixture at the stagnation point on the body, at the bow point of the wave, and at the gas stream splitting point between the other two is calculated by the Bernoulli integral. A method of solution is outlined for vortical hypersonic flow, thermodynamic relations being

used for prior determination of the vorticity of each phase in the spherical bow shock wave. E. A. K.

## 03

### AIR TRANSPORTATION AND SAFETY

Includes passenger and cargo air transport operations; and aircraft accidents.

**A85-16240\*#** National Aeronautics and Space Administration  
Ames Research Center, Moffett Field, Calif.  
**A USER-OPERATED MODEL TO STUDY STRATEGY IN AIRCRAFT EVACUATION**

D. E. CAGLIOSTRO (NASA, Ames Research Center, Chemical Research Projects Office, Moffett Field, CA) *Journal of Aircraft* (ISSN 0021-8669), vol. 21, Dec. 1984, p. 962-965.

A computer model is described to study strategies used by passengers evacuating a burning aircraft. Two baseline cases are presented to demonstrate the model. In the first case, in a simple scenario, strategies were found to change from even movement to the nearest exit to others farthest from the fire. In the second case, a test studying the effects of obstacles on passenger movement, nonlinear effects were found that may increase the time required to escape. The presence of obstacles created bottlenecks and, in some cases, isolated whole sections of the passenger cabin, making it impossible to escape. This occurred even though exits were still available for escape, but passengers could not reach them. Author

**A85-16536**  
**SHALL SAFETY BE MAINTAINED?**

J. M. RAMSDEN *Flight International* (ISSN 0015-3710), vol. 126, Nov. 17, 1984, p. 1328-1331

Several air accidents are discussed to demonstrate that detailed maintenance and damage repair reporting can lead to enhanced flight safety. Note is taken of unreported or unread repair efforts that changed the handling qualities of aircraft or revealed generic problems with particular designs. Details of fuel gage, engine pylon, cargo door, and other structural failure incidents that lead to fatalities are described. Numerous tire-failure-induced accidents are reviewed, with mention given to the effectiveness of runway watchmen who can alert pilots to problems which may not be readily apparent. National confidential problem reporting publications are cited as effective venues for maintaining industry-wide awareness of potentially hazardous equipment or conditions. M. S. K.

**A85-16819**  
**LOSS OF CABIN PRESSURE IN CANADIAN FORCES EJECTION SEAT AIRCRAFT, 1962-1982**

C. J. BROOKS (Defence and Civil Institute of Environmental Medicine, Downsview, Ontario, Canada) *Aviation, Space, and Environmental Medicine* (ISSN 0095-6562), vol. 55, Dec. 1984, p. 1154-1163. refs

A review of all aircraft accidents and incidents in the Canadian Forces over the last 20 years (1962-1982) has been carried out. There have been 47 cases of serious loss of cabin pressurization in ejection seat equipped aircraft. Altitudes varied from 15,000 to 54,000 ft (4,572-16,459 m). No one aircraft appears to be more vulnerable. The most common cause was problems with the canopy seal (25 percent). There were three cases of hypoxia and two cases of decompression sickness. No deaths or permanent injuries occurred. Loss of pressurization is an extremely low, but definite risk to the pilot and aeromedical training with practical demonstration in the hypobaric chamber should continue. Author

A85-18843#

**NUMERICAL SIMULATIONS OF THE EFFECT OF VENTILATION CONTROL ON FIRE AND SMOKE SPREAD IN AIRCRAFT CABINS**

B. P. DE SOUZA, K. T. YANG (Notre Dame, University, Notre Dame, IN), and J. R. LLOYD (Michigan State University, East Lansing, MI; Notre Dame, University, Notre Dame, IN) American Society of Mechanical Engineers, National Heat Transfer Conference, Niagara Falls, NY, Aug. 5-8, 1984 8 p Research supported by the University of Notre Dame refs (Contract NBS-NB-81-NADA-2000) (ASME PAPER 84-HT-104)

The effects of ceiling and floor vents on the spread of fire and smoke in a simulated aircraft fuselage are studied numerically. The cabin contains six rows of seats of two different configurations. closed bottom situation where the seat bottoms rest on the floor and an open bottom situation where the seats are positioned off the floor. Various combinations of injection and suction at the floor and ceiling vents at two different venting rates with the simulated fire present between the middle seats are utilized in the simulation. It is shown that different venting combinations affect the venting of hot gases in the cabin significantly. Author

**N85-13788#** National Transportation Safety Board, Washington, D. C. Bureau of Accident Investigation

**AIRCRAFT ACCIDENT REPORT, SCANDINAVIAN AIRLINES SYSTEM, FLIGHT 901, McDONNELL DOUGLAS DC-10-30, JOHN F. KENNEDY INTERNATIONAL AIRPORT, JAMAICA, NEW YORK, FEBRUARY 28, 1984**

15 Nov 1984 86 p (PB84-910415, NTSB/AAR-84/15) Avail: NTIS HC A05/MF A01

The landing and crash of Scandinavian Airlines System's Flight 901 are discussed. On February 28, 1984, Scandinavian Airlines System Flight 901, a McDonnell Douglas DC-10-30, was regularly scheduled international passenger flight from Stockholm, Sweden, to New York City, New York, with an en route stop at Oslo, Norway. Following an approach to runway 4 right at New York's John F. Kennedy International Airport, the airplane touched down about 4,700 ft (1,440 meters) beyond the threshold of the 8,400 foot (2,560 meter) runway and could not be stopped on the runway. The airplane was steered to the right to avoid the approach light pier at the departure end of the runway and came to rest in Thurston Basin, a tidal waterway located about 600 ft from the departure end of runway 4R. The 163 passengers and 14 crewmembers evacuated the airplane safely, but a few received minor injuries. The nose and lower forward fuselage sections, wing engines, flaps, and leading edge devices were substantially damaged at impact. The weather was ceiling 200 ft overcast, 3/4 mile visibility, with light drizzle and fog. The temperature was 47 F with the wind from 100 at 5 knots. The surface of the runway was wet, but there was no standing water. R. J. F.

**N85-13789#** National Transportation Safety Board, Washington, D. C. Bureau of Accident Investigation

**AIRCRAFT ACCIDENT REPORT, WESTERN HELICOPTERS, INC., BELL UH-1B, N87701, VALENCIA, CALIFORNIA, JULY 23, 1982**

30 Oct. 1984 39 p Supersedes NTSB/AAR-84/02 (PB84-910414, NTSB/AAR-84/14, NTSB/AAR-84/02) Avail: NTIS HC A03/MF A01

The helicopter was being used in conjunction with the filming of a motion picture scene depicting a village typical of villages in Viet Nam which was under attack from heavy ordnance. The helicopter was used as a camera platform as well as playing an active role in the movie sequence. The helicopter was hovered about 25 feet above the village and nearly directly above the location where special effects explosives were detonated to simulate the heavy ordnance. As the pilot turned his helicopter to the left to provide camera coverage, the helicopter's tail section was engulfed in a fireball created by the detonation of a special effect explosion. The tail rotor assembly separated the helicopter descended out of control. The helicopter's main rotor blade struck

and fatally injured three actors on the ground. The six occupants on the helicopter sustained minor injuries, and the aircraft was damaged substantially. Author

**N85-13790#** National Transportation Safety Board, Washington, D. C. Bureau of Accident Investigation

**AIRCRAFT ACCIDENT REPORT AIR CANADA, LOCKHEED L-1011, C-FTNJ, NEAR CHARLESTON, SOUTH CAROLINA, NOVEMBER 24, 1983**

16 Oct 1984 36 p (PB84-910413, NTSB/AAR-84/13) Avail: NTIS HC A03/MF A01

At 1916.02, Air Canada flight 965 was cleared to climb and maintain flight level (FL) 370 from FL 350. About 2 minutes later, the ground controller asked the flight to start a turn to the north because of other traffic. The captain stated that he may have to detour around some thunderstorms and also replied that he was in the turn. About 8 minutes later, the flight encountered severe turbulence which lasted several seconds. One flight attendant and three passengers were seriously injured during the encounter, and two physicians aboard the flight provided immediate medical attention. The flight continued to its destination and landed without further incident about 1 1/2 hours after the accident. Medical assistance was available at the gate to provide treatment when the flight arrived. The National Transportation Safety Board determines that the probable cause of the accident was an encounter with severe clear air turbulence produced by the intrusion of thunderstorm cells into strong winds aloft. Author

**N85-13791# Hoechst A. G., Frankfurt am Main (West Germany) TO TAKE OFF AND TO LAND SAFELY, HOECHST 1678 FOR ICE AND SNOW FREE RUNWAYS [SICHER STARTEN-SICHER LANDEEN HOECHST 1678 FUER EIS- UND SCHNEEFREIE LANDEBAHNEN]**

May 1983 20 p In GERMAN Original contains color illustrations Avail: NTIS HC A02/MF A01

A chemical deicer for runways, based on nontoxic glycols was developed. It is biodegradable, compatible with thermal deicing, and can be combined with granulated urea. Combined thermal and chemical deicing to reduce runway erosion is proposed. With the aid of clearing vehicles, the ice can be removed after 20 to 45 min. Author (ESA)

**N85-13792# European Space Agency, Paris (France) GERMAN DOMESTIC SCHEDULED AIR TRANSPORT IN THE YEAR 2000**

R. J. HAUPPT May 1984 94 p refs Transl into ENGLISH of "Innerdeut. Linienluftverkehr des Jahres 2000", DFVLR, Cologne Rept DFVLR-FB-83-03, 1983 (ESA-TT-828, DFVLR-FB-83-03) Avail: NTIS HC A05/MF A01, original German version available from DFVLR, Cologne DM 28 60

Supply alternatives for domestic scheduled air transport in Germany, based on the year 2000, are presented and evaluated. The financial effects of changes in the available services on an air transport company and on airports (altered revenue from landing charges) are shown, based on a forecast of the air transport market from a cost/revenue calculation model for this market. Substitution effects involving high-speed rail transport are presented. Author (ESA)

**N85-14803#** Toronto Univ., Downsview (Ontario)

**A STUDY OF CRASHWORTHINESS OF LIGHT AIRCRAFT FUSELAGE STRUCTURES: A NUMERICAL AND EXPERIMENTAL INVESTIGATION**

A. P. NANYARO Sep 1984 193 p refs Sponsored by Natural Sciences and Engineering Research Council of Canada and Canadian Transportation Development Agency (UTIAS-286; ISSN-0082-5255) Avail: NTIS HC A09/MF A01

A combined analytical and experimental program was undertaken to study the crashworthiness of light aircraft fuselage structures. In the analytical study, a self-consistent system of

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equations was developed using the finite element method. These equations were linearized (in terms of displacements and angular velocities) and extended to include material nonlinearities. Rib and curved plate elements which include all rigid-body modes were also derived utilizing a matrix formulation to provide ease in programming. The system of equations was then solved using an implicit Newmark-Beta method with the Frontal Solver routine, that avoids inverting the matrices at every time step. This technique requires smaller computer storage than a banded storage method and has other implicit advantages such as stability and accuracy. In addition, a pendulum gantry crash facility was designed and constructed to test scale model stiffened aluminum fuselage structures in a simulated free-flight impact mode. Tests were carried out and dynamic measurements were made of selected g-loads (accelerations) and component strains. B.W.

**N85-14805#** National Transportation Safety Board, Washington, D. C. Bureau of Safety Programs  
**ANNUAL REVIEW OF AIRCRAFT ACCIDENT DATA: US GENERAL AVIATION, CALENDAR YEAR, 1981**  
6 Aug 1984 156 p refs  
(PB84-230960, NTSB/ARG-84/02) Avail NTIS HC A08/MF A01 CSCI 01B

This report presents a statistical compilation and review of general aviation accidents which occurred in 1981. The accidents reported are all those involving U.S. registered aircraft not conducting air carrier revenue operations under 14 CFR 121, 14 CFR 127, or 14 CFR 135. The report is divided into sections, each of which presents a review of a subset of all general aviation accidents. Each subset represents aircraft of similar types or aircraft being operated for particular purposes. Several tables present accident parameters for 1981 only, and each section includes tabulations which present comparative statistics for 1981 and for the five-year period 1976-1980. Author (GRA)

## 04

### AIRCRAFT COMMUNICATIONS AND NAVIGATION

Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.

**A85-17450**  
**METHOD FOR CALCULATION OF ATC-FACILITY CAPACITY UTILIZATION IN PREPLANNING AIR-TRAFFIC MOVEMENTS [METHODIK ZUR BERECHNUNG DER KAPAZITAETSAUSLASTUNG VON FLUGSICHERUNGSTELLEN BEI DER VORAUSSPLANUNG VON FLUGBEWEGUNGEN]**

W. KUNERT (Interflug Gesellschaft fuer internationalen Flugverkehr mbH, Berlin, East Germany). Technisch-oekonomische Information der zivilen Luftfahrt (ISSN 0232-5012), vol. 19, no. 4, 1983, p. 131-134, 136. In German.

The procedures in use in the GDR ATC system since 1981 to balance the number of aircraft requiring ATC services in a given zone with the available capacity of the ATC facilities are surveyed. The balancing operation is performed by computers using data submitted by the various stations for each half-hour period of the following day, and printouts of the results are made available to the central planning unit to facilitate prompt action to avoid overloading while minimizing flight delays. The techniques used to compute the normal and peak capacity limits of the ATC stations are described in detail and illustrated with diagrams and graphs. T.K.

### **A85-17807#** **APPLICATIONS OF AIR-GROUND-AIR DIGITAL COMMUNICATION SYSTEM ACARS/AIRCOM**

C. A. BENNETT (Teledyne, Inc., Teledyne Controls, Los Angeles, CA). IN: Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings. New York, American Institute of Aeronautics and Astronautics, 1984, p. 36-39. (AIAA PAPER 84-2604)

Though the U.S.'s air-to-ground VHF digital data link, which provides airliners with efficient and reliable communications, was originally meant to furnish a low volume of short messages, provisions were from the outset made to expand message quality and length. New and planned applications extend to the collection of weather data during both takeoff/climb and cruise, the addition of a complementary HF link to allow communications with areas lacking VHF ground stations, and a satellite link. The system will be able to reduce flight deck workload while providing an increasing amount of data to ground controllers. O.C.

### **A85-17812#** **INFRARED SEARCH AND TRACK SYSTEM DEVELOPMENT**

W. E. MOORE, M. SPECTOR, and V. D. BEST (USAF, Wright-Patterson AFB, OH). IN: Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings. New York, American Institute of Aeronautics and Astronautics, 1984, p. 65-67. (AIAA PAPER 84-2610)

High altitude/high velocity aircraft targets radiate intensely in the IR in virtue of skin friction, propulsion system-heated structures, and hot exhaust gases. This makes possible long range IR detection and tracking by means of passive systems that are not hindered by electronic jamming. Attention is presently given to the U.S. Air Force's IR Search and Track (IRST) advanced development program. The two IRST devices under development are each to be carried aloft in a pod that will be mounted for flight testing on an F-15 interceptor's missile pod. The IRST device ultimately chosen in view of test flight result evaluations will complement airborne intercept radar operations. O.C.

### **A85-17813#** **THE APG-66 RADAR AND ITS DERIVATIVE APPLICATIONS**

L. J. KUCHINSKI and T. R. PATTON (Westinghouse Electric Corp., Baltimore, MD). IN: Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings. New York, American Institute of Aeronautics and Astronautics, 1984, p. 68-75. (AIAA PAPER 84-2609)

The APG-66 radar, originally designed for the F-16 aircraft, is a paradigmatic example of an avionics system possessing the degree of modularity with which to handle a wide range of applications. These have thus far included a drug traffic vessel-spotting radar for the U.S. Customs Service, a lookdown radar for Japanese F-4 interceptors, and the Sgt. York Divisional Air Defense anti-aircraft vehicle's fire control radar. The APG-68 second-generation derivative of the APG-66 is even more versatile, since its individual LRUs have greater flexibility. A variant of the APG-68 is being developed for the B-1B bomber. O.C.

### **A85-17843#** **ENHANCED TCAS II SIGNAL PROCESSOR DEVELOPMENT**

B. J. LYONS and M. A. MARTIN (Bendix Corp., Communications Div., Baltimore, MD). IN: Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings. New York, American Institute of Aeronautics and Astronautics, 1984, p. 277-284. (AIAA PAPER 84-2656)

The procedures and simulations performed in the development of the enhanced traffic alert and collision avoidance system (TCAS II) are outlined. TCAS II was produced with iterative application of block diagrams and progressively finer tuned definitions of low-level (LLS) and high-level (HLS) simulations, signal processor specifications, and hardware designs. LLS considered the signal processor features and HLS defined the hardware functions. Flight



tests, the final phase, were made on a 707 and correctly recommended a flight path change that avoided a potential collision situation  
M S K

**A85-17855#**  
**INTEGRATED AVIONICS FOR ADVANCED ARMY ROTORCRAFT**

W L EVERSOLE, W F. KICZUK, J A LAMBRECHT, J. J WILLIAMS, R E BRANSTETTER (Texas Instruments, Inc., Dallas, TX), and R. L RIVARD (Thermotron Industries, Holland, MI, Texas Instruments, Inc., Dallas, TX) IN Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings New York, American Institute of Aeronautics and Astronautics, 1984, p 352-358  
(AIAA PAPER 84-2672)

An approach to the development of an advanced avionics architecture to meet the functional requirements of the Army's next generation of rotorcraft (LHX) is presented. Mission requirements are briefly discussed to identify the functional partitioning of the LHX system. This is followed by a brief overview of each subsystem. The requirements of the processing algorithms are discussed to quantitatively identify the performance requirements of the avionics architecture. Also described is a multiprocessor, multisensor architecture involving high bandwidth sensors, low bandwidth sensors and a hierarchy of processing structures and interconnections that provides the flexibility, reliability, availability and fault tolerance within the power, volume, and weight constraints imposed by LHX  
Author

**A85-17856\*#** National Aeronautics and Space Administration  
Ames Research Center, Moffett Field, Calif  
**EVALUATION OF A REAL-TIME PREDICTIVE GUIDANCE LAW FOR LANDING VTOL AIRCRAFT AT SEA**

C. H PAULK, JR (NASA, Ames Research Center, Moffett Field, CA) and A V PHATAK (Analytical Mechanics Associates, Inc., Mountain View, CA) IN: Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings New York, American Institute of Aeronautics and Astronautics, 1984, p 359-371 refs  
(AIAA PAPER 84-2673)

A piloted simulation evaluation was conducted to assess the merits of a predictive lull/swell guidance law for landing a vertical takeoff and landing aircraft at sea. Two cases were evaluated. The first was performed by the pilot without the aid of the lull/swell guidance indicator, which indicates a landing opportunity. The second was performed in a similar manner with the aid of the guidance indicator. The pilot was instructed to use the guidance indicator only as a landing aid. The results indicated the pilots were able to visually determine ship lulls and swells prior to landing. However, use of the lull/swell guidance resulted in increased pilot confidence in the existence of a landing opportunity, which resulted in significantly shorter hover waiting times prior to landing. The performance of the lull/swell guidance was conservative, in that it forecast the onset of deck lulls and swells later than the pilot could detect them, but with greater reliability and therefore greater pilot confidence. In no instances did the guidance algorithm predict a false ship lull with which the pilot did not agree.  
Author

**A85-17857#**  
**DIGITAL AVIONICS AND FLIGHT PATH DIRECTOR FUNCTIONS OF THE HH-60 HELICOPTER**

F G KILMER, R L. KILMER, and B A. THALACKER (IBM, Federal Systems Div., Owego, NY) IN Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings New York, American Institute of Aeronautics and Astronautics, 1984, p. 372-378 refs  
(AIAA PAPER 84-2674)

The HH-60 helicopter horizontal and vertical guidance techniques, flight director modes, and display cue symbology are described. Terminal area approach to a hover and terrain following over an isolated peak are demonstrated by means of non-real time simulation. The paper concludes with a plan for piloted

helicopter simulation at the NASA-Ames facility to further evaluate director and display concepts  
Author

**A85-17858\*#**  
**APPLICATION OF DIFFERENTIAL GPS TO CIVIL HELICOPTER TERMINAL GUIDANCE**

R P DENARO (Tau Corp., Los Gatos, CA) IN Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings New York, American Institute of Aeronautics and Astronautics, 1984, p 379-385 NASA-sponsored research refs  
(AIAA PAPER 84-2676)

NASA is conducting a research program to evaluate differential Global Positioning System (GPS) concepts for civil helicopter navigation. It is pointed out that the civil helicopter community will probably be an early user of GPS because of the unique mission operations in areas where precise navigation aids are not available. Applications with very demanding accuracy requirements are related to remote area search and rescue, offshore oil platform approach, remote area precision landing, and other precise navigation operations. Differential GPS appears to provide a solution for meeting the accuracy requirements involved in the considered operations. The present investigation is concerned with results obtained in three areas studied in connection with the conducted research program. Attention is given to mission-tailored satellite selection, a satellite selection algorithm concept, satellite selection algorithm simulation results, and differential GPS ground station design  
G R

**A85-17869#**  
**AN EXPERIMENTAL AERONAUTICAL SATELLITE DATA LINK**

S ANDERSON (Mitre Corp., McLean, VA) IN Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings New York, American Institute of Aeronautics and Astronautics, 1984, p 454-461 refs  
(AIAA PAPER 84-2691)

The current status of a project to design, develop, and demonstrate an experimental aeronautical satellite data link system to provide data communication capability between the ground and aircraft flying in oceanic airspace is reported. The approach used in developing the system is described, and technical details are presented to support specific design decisions. The link between the aircraft and satellite is at L-band (1.5/1.6 GHz), and the links between satellite and earth stations are at C-band (4/6 GHz). The system concept avoids the high cost of launching, operating, and maintaining dedicated satellites through sharing of existing commercially available satellite links (e.g., INMARSAT) with other mobile users (e.g., maritime).  
V L

**A85-17870#**  
**AN ADAPTIVE AIRBORNE VLF COMMUNICATIONS ARRAY CONCEPT**

S R. SCHMITT (U.S. Navy, Naval Air Development Center, Warminster, PA) IN Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings New York, American Institute of Aeronautics and Astronautics, 1984, p 462-466. refs  
(AIAA PAPER 84-2698)

A digital signal processing algorithm based on the Kalman filter is shown to be suitable for use in an airborne adaptive low frequency communications array. The Kalman filter is used to adjust the weights in a weighted sum of antenna element outputs in order to minimize the mean square error between this sum and a replica of the transmitted waveform. The algorithm uses decision aiding in which bit decisions indicate the correct replica waveform used in estimation of the optimal weights. An impulsive noise suppression subroutine is included as part of the algorithm to reduce the effects of atmospheric noise  
Author

## A85-17876#

### AVIONICS HARDWARE DESIGN FOR TESTABILITY

B. L. FERRELL and S. L. OVER (General Dynamics Corp., Fort Worth, TX) IN: Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings New York, American Institute of Aeronautics and Astronautics, 1984, p 498-502. refs  
(AIAA PAPER 84-2708)

Design strategies to improve the onboard testability of avionics hardware are discussed in the light of the ongoing trend toward higher degrees of integration in electronic equipment. Current problems in fault detection and isolation are reviewed; the time limitations of manual or software-resident test routines are indicated, and the need for integrated-circuit-level continuous or semicontinuous self-testing for the components of the 1990s is stressed. An overall test strategy employing a hierarchic arrangement of on-chip self-tests, module-test controllers, subsystem-test controllers, and a fault-management system is recommended. T K

## A85-17877#

### REMOTE MAINTENANCE MONITORING USING A DIGITAL DATA LINK

D. DOWLING (ARINC Research Corp., Annapolis, MD) and R. A. LANCASTER IN: Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings New York, American Institute of Aeronautics and Astronautics, 1984, p 503-507.  
(AIAA PAPER 84-2677)

It is noted that the trend toward digital avionics in new aircraft, which capitalize in built-in test methods, compels significant changes in the conventional approaches to avionics maintenance. A maintenance concept is proposed which employs data links to permit the remote monitoring of maintenance data. On the basis of the advance notice of faults in avionics equipment and engine performance degradation which would be thus obtained, a more efficient scheduling of maintenance activity could be devised. This scheduling improvement would extend to a prepositioning of replacement parts. O C

## A85-17882#

### THE NAVY'S TACTICAL DATA NETWORK

W. J. SCHOPPE (U.S. Naval Material Command, Naval Air Development Center, Warminster, PA) IN: Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings New York, American Institute of Aeronautics and Astronautics, 1984, p 531-538. refs  
(AIAA PAPER 84-2716)

The functional features, organization, hardware, and applications of the U.S. Navy Tactical Data System (NTDS) are outlined. Comprising marine, airborne and land-based computer systems linked through UHF frequencies, the NTDS provides message and communications exchanges between naval units for tactical purposes. The main thrust is to transfer target data rapidly between platforms using standardized messages, RF modulation, and data link protocols. Primary attention is given to anti-air warfare and anti-submarine warfare. For example, E-2C Hawkeye aircraft carrying a rotodome provide target movement data for real-time target vectoring analysis, which is transmitted to several airborne F-14A and/or F/A-18 fighters. Details of the phase-shift keyed connectivity management techniques are provided. M S.K.

## A85-17883#

### IMPLICATIONS OF JOINT TACTICAL INFORMATION DISTRIBUTION SYSTEM/TACTICAL DIGITAL INFORMATION LINK J ON NAVY AIRCRAFT WEAPONS SYSTEMS

R. W. KUHN (McDonnell Aircraft Co., St. Louis, MO) IN: Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings New York, American Institute of Aeronautics and Astronautics, 1984, p 539-548  
(AIAA PAPER 84-2719)

The technical difficulties associated with incorporating the Joint Tactical Information Distribution System/Tactical Digital Information

Link JTIDS/TADIL J into naval tactical aircraft are discussed. A detailed description of the system is presented, and its role in coordinating control, weapons and sensor information in a communications jamming environment is analyzed. The integration of a JTIDS/TADIL J system in the electronics complement of the F/A-18 A tactical aircraft is considered, with emphasis on its compatibility with second generation command, control, and communications electronic systems including the Advanced Medium Range Air-to-Air Missile (AMRAAM), the Global Positioning System (GPS); the Harpoon air-to-surface and surface-to-surface missiles, and the Automatic Target Recognition System (ATR). A wiring diagram is provided which describes the interfaces between the various JTIDS/TADIL J systems. I.H.

## A85-17885#

### A TERRAIN DATA/DIGITAL MAP SYSTEM FOR LHX

G. O. BURNHAM, C. BENNING, and R. RIVARD (Texas Instruments, Inc., Lewisville, TX) IN: Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings New York, American Institute of Aeronautics and Astronautics, 1984, p 557-562.  
(AIAA PAPER 84-2723)

The avionics functions required for the U.S. Army's Light Helicopter (LHX) are discussed. Particular attention is given to a description of the terrain data processing/digital map retrieval system (TDP/DMRS) for coordinating avionics functions. The terrain data/digital map system of the LHX converts stored digital map data into a form more useful for avionics system algorithms. The system has three major subsystems: data retrieval, processing algorithms; and display formatting. The computational procedures used by each individual subsystem of the TDS/DMS are described in detail. The throughput requirements of the system are given in a table. I H.

## A85-17888#

### EVOLUTION OF THE COLLISION AVOIDANCE SYSTEM IN THE COCKPIT

W. L. HYLAND (FAA, Washington, DC) IN: Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings New York, American Institute of Aeronautics and Astronautics, 1984, p 573-576. refs  
(AIAA PAPER 84-2734)

The evolution and operational implementation of the Traffic Alert and Collision Avoidance System (TCAS), developed by the FAA, is presented, with emphasis on pilot interface with the system. The TCAS is an actively interrogating airborne system, operating in the air traffic control radar beacon band. The system shares the panel space by using the already developed Integrated IVSI for resolution advisories, and the Weather Radar display for traffic advisory information. It displays all aircraft within 4 miles and + or - 1200 feet of own aircraft, and provides vertical direction of the threat if its rate exceeds 500 fpm. The TCAS is shown to increase the pilot's involvement in decision-making processes, minimizing possible misinterpretation or misuse of information. It is now ready for evaluation by line pilots. L T

## A85-17889#

### ENHANCED TCAS II TRACKING ACCURACY

A. I. SINSKY, J. E. REED (Allied Bendix Aerospace, Bendix Communications Div., Baltimore, MD), and J. J. FEE (FAA, Washington, DC) IN: Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings New York, American Institute of Aeronautics and Astronautics, 1984, p 577-585. Sponsorship: U.S. Department of Transportation. refs  
(Contract DOT-FA01-82-C-10019, DOT-FA01-81-C-10041)  
(AIAA PAPER 84-2738)

The construction, operation parameters, and tracking accuracy of the Enhanced TCAS II airborne collision avoidance system are analyzed. The system, an ATRBS/mode S interrogator, using top and bottom mounted, eight-element, electronically-scanned circular arrays, and a sum and difference beam, monopulse angle-measuring system. Tests performed at a selected FAA Test Airport included airborne angle calibrations, as well as midair

encounters. Transmissions at 1030 MHz are radiated in each of the 64 electronically selected beam positions, resulting in 360-degree azimuth coverage with the interrogated sector reduced to 22.5 degrees - a 3-to-1 total reduction in the 64-degree half-power sum beam width. A pair of X-band NIKE beacon trackers were used to acquire precision position reference data on both the target and own aircraft. The angle measurements are shown to be of sufficient accuracy so that collision can be avoided when a reasonable horizontal maneuver is executed within 25 seconds of a projected collision. L.T.

#### A85-17890#

##### NEW CONCEPTS IN COLLISION AVOIDANCE LOGIC

W. D. LOVE and A. D. ZEITLIN (Mitre Corp., McLean, VA) IN: Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings. New York, American Institute of Aeronautics and Astronautics, 1984, p. 586-592. (AIAA PAPER 84-2737)

Airborne collision avoidance logic is being developed to take advantage of the accurate bearing measurements provided by the Enhanced TCAS II system. This system issues horizontal and vertical resolution advisories, and should give fewer unnecessary alarms than earlier systems. Design tradeoffs and new techniques are described for threat detection, modeling of potential escape maneuvers, and the selection of resolution advisories. Plans for further development and evaluation are described. Author

#### A85-17891#

##### IMPROVED TCAS I FOR PILOT WARNING INDICATION

J. D. WELCH and W. H. HARMAN (MIT, Lexington, MA) IN: Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings. New York, American Institute of Aeronautics and Astronautics, 1984, p. 593-596. FAA-sponsored research. refs. (AIAA PAPER 84-2736)

Recent improvements to the interference standards for the TCAS I airborne collision avoidance system (mode C interrogations) are considered, based on the more general limits for TCAS II devices. The changes are aimed at increasing the operating power of the devices by selecting the power according to the actual, rather than worst-case, environment. It is also noted that knowledge of transponder rate, as well as use of the mode S transponders, can yield an increase in power. In addition, a specific TCAS I design is discussed, which employs 'whisper-shout' scheme to avoid the overlapping of multiple targets. The new interference standards are shown to allow considerably higher values of interrogation power without interference with other systems operating at or near 1030 and 1090 MHz. New power limits as a function of the number of aircraft within 3.5 n mi are shown. L.T.

#### A85-17892#

##### SECONDARY SURVEILLANCE RADAR MODE S POTENTIAL APPLICATIONS AND FUTURE REQUIREMENTS IN EUROPE

R. C. G. JENYNS and M. E. COX (European Organization for the Safety of Air Navigation, Brussels, Belgium) IN: Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings. New York, American Institute of Aeronautics and Astronautics, 1984, p. 597-605. refs. (AIAA PAPER 84-2735)

The Secondary Surveillance Radar (SSR) as used in the European environment is examined, and potential operational benefits of the use of the SSR mode S, as opposed to the mode A codes currently used, are considered. A program of work, including real-time simulations, to study the role of the data link capability of mode S in two-way communications between the air traffic control system and the aircraft is described together with initial results. Other studies related to the data link applications include the acquisition and exploration on the ground of data available from the aircraft system. The Airborne Collision Avoidance System is also discussed as an option for enhancing air traffic safety. The aircraft identification functions are expected to be a requirement for mode S transponders at least in the

EUROCONTROL region. Block and schematic diagrams of the experimental systems are provided. L.T.

#### A85-18145

##### RAMP'S NEW PRIMARY SURVEILLANCE RADAR

J. D. DYCK (Transport Canada, Ottawa, Canada) and H. R. WARD (Raytheon Co., Wayland, MA) Microwave Journal (ISSN 0026-2897), vol. 27, Dec 1984, p. 105, 106, 108 (3 ff.). refs.

In Canada, a program known as the Radar Modernization Project (Ramp) has been started to modernize the entire air traffic control radar system. The decision to replace existing radar systems was made in 1981. Much of the equipment involved is based on the employment of tubes. The replacement of the existing equipment has the object to improve system reliability, reduce maintenance costs, improve performance to the capability of 1980 technology. The Ramp System will consist of the most modern equipments available with considerable capability for future enhancements. Particular attention is given to the primary surveillance radar (PSR) which uses the radar echo to measure an aircraft's position. The PSR, operating at L band, gives coverage to a range of 80 nmi and to an altitude of 23,000 feet with 80 percent probability of detection. It provides also weather contour information to a range of 100 nmi. G.R.

#### A85-18326#

##### LINE-OF-SIGHT RECONSTRUCTION FOR FASTER HOMING GUIDANCE

F. W. NESLINE and P. ZARCHAN (Raytheon Co., Missile Systems Div., Bedford, MA) (Guidance and Control Conference, Gatlinburg, TN, August 15-17, 1983, Collection of Technical Papers, p. 67-74) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 8, Jan-Feb 1984, p. 3-8. Previously cited in issue 19, p. 2796, Accession no. A83-41666. refs.

#### A85-18345#

##### MODELING OF CERTAIN STRAPDOWN HEADING-SENSITIVE ERRORS IN INS ERROR MODELS

I. Y. BAR-ITZHACK (Technion - Israel Institute of Technology, Haifa, Israel) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 8, Jan-Feb 1984, p. 142-144. refs.

It is pointed out that self-alignment of a gimbaled inertial navigation system (INS) results in a platform tilt which cancels the effect of the level accelerometer biases. The same cancellation takes place in strapdown INS too. However, unlike gimbaled INS, in a strapdown system, this cancellation is perturbed once the INS changes heading. In the present investigation it is shown that the standard strapdown INS error model describes the heading-sensitive phenomenon. It is found that the matrix regarding the transformation from the body to the reference coordinate system plays a major role in the modeling of the phenomenon. G.R.

#### A85-18346#

##### THE GENERAL CLASS OF OPTIMAL PROPORTIONAL NAVIGATION

W. PFLEGHAAR (Messerschmitt-Boelkow-Blohm GmbH, Munich, West Germany) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 8, Jan-Feb 1984, p. 144-147. refs.

Certain difficulties can arise in connection with proportional navigation (PN) guidance schemes and the application of modern control theory to the field of guidance laws. The present investigation is concerned with a reformulation of the kinematic guidance problem, taking into account the derivation of a general optimal guidance law on the basis of linear quadratic controller design theory. The employed approach differs from previous procedures in three points. One point is related to the use of a scalar state formulation which is valid near impact. The second difference is represented by the use of an optimization interval for which the terminal time is an open design parameter, while the use of the standard regulator format with running cost on the system state provides a third difference. G.R.

**A85-18718**

## **THE AVIONICS FLIGHT TEST SYSTEM [DAS AVIONIK-FLUGERPROBUNGSSYSTEM (AFES)]**

K HURRASS (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Institut fuer Flugfuehrung, Brunswick, West Germany) DFVLR-Nachrichten (ISSN 0011-4901), vol 43, Nov. 1984, p 29-31 In German.

The DFVLR in cooperation with a German technical university have developed a high-performance measuring system for the conduction of flight tests with new navigation and flight control systems. The establishment of a high-precision reference flight path is of central significance, taking into account, in particular, the evaluation of the performance of systems of navigation. The new measuring system makes use of a ground-based laser-tracking device and a ground-based tracking radar, while the experimental aircraft is equipped with an inertial navigation system (hybrid system) The measured data obtained on the ground and in the aircraft are exchanged by means of telemetry, and are optimally connected with the aid of filter and smoothing algorithms The positional accuracy attained for the flight path can be as high as + or - 0.1 m, whereas the accuracy for the velocity is up to + or - 0.1 m/s. The center of the considered system is the central station, which provides the communication links with the different subsystems and processes the flight test data G R.

## **N85-13793# Mitre Corp., McLean, Va Metrek Div TCAS 2 LOGIC PERFORMANCE DURING PHASE ONE OPERATIONAL EVALUATION Final Report**

L B ZARRELLI Washington FAA Oct. 1984 64 p refs (Contract DTFA84-C-00001) (DOT/FAA/PM-84/20, MTR-84W107) Avail NTIS HC A04/MF A01

This document describes the performance of the collision avoidance logic during the Phase I Operational Evaluation of the Traffic Alert and Collision Avoidance System called Minimum TCAS II Between November 1981 and March 1982, TCAS units were installed on two Piedmont Airlines B727 aircraft flown on regularly scheduled passenger flights For this phase of testing, data was recorded while trained observers viewed the TCAS advisories However, these displays were not shown to the flight crew The analysis of logic performance first required identification and removal of alerts caused by hardware or software problems that were subsequently fixed, or else caused by problems in the collision avoidance logic which were subsequently removed Examples are shown for which logic improvements correct earlier problems Operational questions, observer comments, and an assessment of the true alert rate are then examined using the recorded data.

Author

**N85-14806\*#** National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

## **TECHNICAL WORKSHOP: ADVANCED HELICOPTER COCKPIT DESIGN**

J. C. HEMINGWAY, ed and G. P. CALLAS, ed Dec 1984 346 p refs Workshop held at Moffett Field, Calif., 26-28 Jul 1983

(NASA-CP-2351; REPT-85057; NAS 1.55:2351) Avail NTIS HC A15/MF A01 CSCL 01D

Information processing demands on both civilian and military aircrews have increased enormously as rotorcraft have come to be used for adverse weather, day/night, and remote area missions Applied psychology, engineering, or operational research for future helicopter cockpit design criteria were identified Three areas were addressed (1) operational requirements, (2) advanced avionics, and (3) man-system integration

**N85-14809\*#** National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif

## **GUIDANCE AND NAVIGATION PROGRAMS AND PLANS**

D G DENERY *In its* Technical Workshop: Advanced Helicopter Cockpit Design Concepts p 23-34 Dec 1984 Avail: NTIS HC A15/MF A01 CSCL 17G

System technology concepts for all weather helicopter operations in both remote and high density areas were examined. The SH-36 was used to support the remote area investigations. The primary emphasis was on the development of advanced navigation concepts to allow rotorcraft to land in remote areas where there may not be a ground based navigational aid The focus was on the used airborne weather radar, the use of high resolution radar and satellite based navigation concepts The high density work was conducted using the UH-1H system that allows alternate guidance and navigation algorithms to be tested in flight B G.

**N85-14827\*#** Sikorsky Aircraft, Stratford, Conn.

## **AVIONICS SYSTEM DESIGN FOR REQUIREMENTS FOR THE UNITED STATES COAST GUARD HH-65A DOLPHIN**

D A YOUNG *In* NASA Ames Research Center Technical Workshop Advan. Helicopter Cockpit Design Concepts p 285-293 Dec. 1984

Avail. NTIS HC A15/MF A01 CSCL 01D

Aerospatiale Helicopter Corporation (AHC) was awarded a contract by the United States Coast Guard for a new Short Range Recovery (SRR) Helicopter on 14 June 1979 The award was based upon an overall evaluation of performance, cost, and technical suitability In this last respect, the SRR helicopter was required to meet a wide variety of mission needs for which the integrated avionics system has a high importance. This paper illustrates the rationale for the avionics system requirements, the system architecture, its capabilities and reliability and its adaptability to a wide variety of military and commercial purposes Author

**N85-14828\*#** Huntington Beach Police Dept., Calif

## **THE NEED FOR A DEDICATED PUBLIC SERVICE HELICOPTER DESIGN**

R MORRISON (Airborne Law Enforcement Association, Inc.) *In* NASA Ames Research Center Technical Workshop Advan. Helicopter Cockpit Design Concepts p 295-315 Dec 1984 refs

Avail: NTIS HC A15/MF A01 CSCL 01D

The need to provide the necessary funding to research, design and contract the building of an advanced technology rotorcraft that will meet the mission demands of public service (fire, police, paramedics and rescue) operators is discussed Noise and cost factors, the greatest objections on the part of many police and public administrators are addressed The growth of helicopter utilization in public service is documented B W

**N85-14830#** Toronto Univ. (Ontario) Inst for Aerospace Studies

## **CRITICAL CONDITIONS FOR THE AUTOMATIC CONTROL OF LANDING FROM DECISION HEIGHT IN VARIABLE WINDS**

S. G CAVALCANTI Oct 1984 299 p refs (UTIAS-284, ISSN-0082-5255) Avail NTIS HC A13/MF A01

The critical conditions at decision height that could cause unsafe landing situations were investigated. The analysis of these conditions was performed using a method of automatic control which employs the reference state vector and the reference control vector. A landing tunnel approach was developed using airspeed and altitude as the basic variables with corrections for sink rate and allowance for the presence of wind shear The landing tunnel concept consists of a landing window that varies with altitude allowing for the possibility of a go-around decision at any moment during the landing maneuver A procedure for performing the go-around maneuver using a safe minimum height or, if necessary, maximum aircraft capability, was developed which always allows the maximum possible clearance of the ground. An outline of an autoland system incorporating the procedure developed is

presented based on an on-board microprocessor to produce the necessary computations  
B W

## 05

# AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology

## A85-16064

## SOME ENGINEERING ASPECTS OF THE X-29 AIRPLANE

S. DASTIN, H. L. EIDINOFF, and H. ARMEN, JR (Grumman Aerospace Corp., Bethpage, NY) IN Technology vectors, Proceedings of the Twenty-ninth National SAMPE Symposium and Exhibition, Reno, NV, April 3-5, 1984 Covina, CA, Society for the Advancement of Material and Process Engineering, 1984, p 1438-1449. refs

Grumman is currently evaluating aircraft performance benefits using forward rather than aft swept wings. The new design will be validated by actual manned flight under an aircraft demonstration program labelled X-29A. The major structural feature of the airframe is the use of graphite-epoxy composites to provide an optimum solution to the inherent structural divergence problem of forward swept wings. This paper reviews several newer technologies to be demonstrated and integrated to develop future aircraft with improved performance, reduced acquisition costs and increased life and durability  
Author

A85-16106\*# National Aeronautics and Space Administration Flight Research Center, Edwards, Calif

## ROLE OF RESEARCH AIRCRAFT IN TECHNOLOGY DEVELOPMENT

K. J. SZALAI (NASA, Flight Research Center, Research Engineering Div., Edwards, CA) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct 31-Nov 2, 1984 28 p refs  
(AIAA PAPER 84-2473)

NASA supercritical wing technology, and the digital fly-by-wire program are discussed as used on the F-8 research aircraft. Furthermore, the Highly Maneuverable Aircraft Technology (HiMAT) program, using a 0.44-scale, 3500 lb jet-powered remotely piloted research aircraft, is analyzed. Highly accurate data on aerodynamic and structural loads and deflection data were obtained from model flight tests. In addition, an oblique-wing technology is discussed through the example of the piloted AD-1 research aircraft, noting the low cost of the experiment. Other topics include integrated system technology, generic forces of the research aircraft program, and aeronautical technology application trends  
L T

## A85-16199

## EXPERIMENTAL METHODS FOR THE ANALYSIS OF DYNAMIC PHENOMENA FOUND IN HELICOPTERS [METHODES EXPERIMENTALES D'ANALYSE DE PHENOMENES DYNAMIQUES, RELEVES SUR HELICOPTERE]

J.-P. COSTON (Societe Nationale Industrielle Aerospatiale, Division Helicoptere, Marignane, Bouches-du-Rhone, France) (Societe Francaise des Mecaniciens, Journees sur les Vibrations, Paris, France, May 25, 26, 1983) Revue Francaise de Mecanique (ISSN 0373-6601), no 2, 1984, p 73-82. In French

The vibrational eigenmodes of a rotating helicopter rotor are determined using the method of coherence functions, and the modal responses of operating axisymmetric helicopter-gearbox components are investigated analytically for both rotating and fixed reference axes. Some numerical results are presented graphically, and drawings and photographs of typical components and experimental setups and vibration spectra obtained by laser Doppler velocimetry are provided  
T.K.

A85-16239\*# Dayton Univ., Ohio

## A SIMPLE AND SAFE TAKEOFF OR LANDING PROCEDURE WITH WING SURFACE CONTAMINATIONS

M. A. DIETENBERGER (Dayton, University, Dayton, OH) Journal of Aircraft (ISSN 0021-8669), vol. 21, Dec 1984, p 955-961. Previously cited in issue 06, p 718, Accession no A83-19594 refs  
(Contract NAS8-33369)

A85-16241\*# National Aeronautics and Space Administration Langley Research Center, Hampton, Va.

## MICROWAVE-POWERED, UNMANNED, HIGH-ALTITUDE AIRPLANES

C. E. K. MORRIS, JR (NASA, Langley Research Center, Aeronautical Systems Office, Hampton, VA) Journal of Aircraft (ISSN 0021-8669), vol. 21, Dec 1984, p 966-970. Previously cited in issue 17, p 2465, Accession no A83-38657 refs

## A85-17068

## DYNAMIC CHARACTERISTICS OF AN UNLOADING DEVICE [DINAMICHESKIE KHARAKTERISTIKI RAZGRUZOCHNOGO USTROISTVA]

D. E. CHEGODAEV and A. I. POPOV Aviatsonnaia Tekhnika (ISSN 0579-2975), no 2, 1984, p 81-86. In Russian

Results of a study of pneumohydraulic unloading devices for the vibrational testing of flight vehicles and their engines are presented. Some characteristic features of the dynamic behavior of these devices, such as adjustable stiffness and damping and the existence of antiresonance, are identified and verified experimentally. The results obtained provide a way to design unloading devices with specified properties  
V L

## A85-17069

## OPTIMIZATION OF THE PARAMETERS OF TRANSPORT AIRCRAFT WITH A LIFT-GENERATING FUSELAGE [OPTIMIZATSIIA PARAMETROV TRANSPORTNYKH SAMOLETOV S NESUSHCHIM FIUZELIAZHEM]

A. A. BADIAGIN and I. V. CHEPURNYKH Aviatsonnaia Tekhnika (ISSN 0579-2975), no 2, 1984, p 87-89. In Russian

An approximate solution is presented for the problem of optimizing the parameters of an aircraft with a lift-generating fuselage over a wide range of target loads (12.5-200 t). The optimization problem is solved on a computer using the golden section search approach. It is found that the optimum number of engines is largely determined by the target load. The optimum wing aspect ratio is 4.0-5.2, i.e., significantly less than that of the classical subsonic transport aircraft. The optimum bypass ratio of the turbofan engines is determined to be 3.0-4.5  
V L

## A85-17226#

## R&D IN THE EVOLUTION OF THE DASH 8

B. EGGLESTON (De Havilland Aircraft of Canada, Ltd., Downsview, Ontario, Canada) (Canadian Aeronautics and Space Institute, Annual General Meeting, 31st, Ottawa, Canada, May 28, 1984) Canadian Aeronautics and Space Journal (ISSN 0008-2821), vol. 30, Sept 1984, p. 195-212. Research supported by the National Research Council, Transport Canada, and de Havilland Aircraft of Canada, Ltd.

The design process for the DASH 8 twin-turboprop 36 passenger aircraft is traced with an emphasis on technology contributions. The thrust of the effort was to produce a fuel efficient STOL commuter aircraft. Preliminary studies covered the influence of landing field size on the engine required, high or low layouts, cabin cross section, placement of the landing gear, the airfoils and wing span. An 18 percent thick aft-cambered wing was selected to gain lift compared to previous DASH aircraft. NACA 63A-418 airfoils. Half models were subjected to wind tunnel tests for studies of span, nacelle shapes, flap deflections, etc. Surface singularity and panel method codes were used to analyze the aerodynamic flow. Wind tunnel tests were also employed in choosing the 14SF propeller. Kevlar-based composite secondary structures were designed as a weight saving measure. The 33,000 lb aircraft, expected to be certified by September 1984, will require a maximum

## 05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

2990 ft runway and will cruise at 268 kt at a 20,000 ft altitude  
M.S.K.

### A85-17227#

#### A COMPUTER PROGRAM FOR ASSISTING IN THE PRELIMINARY DESIGN OF TWIN-ENGINE PROPELLER-DRIVEN GENERAL AVIATION AIRCRAFT

L R JENKINSON and D SIMOS (Loughborough University of Technology, Loughborough, Leics., England) (Canadian Aeronautics and Space Institute, Annual General Meeting, 31st, Ottawa, Canada, May 28, 1984) Canadian Aeronautics and Space Journal (ISSN 0008-2821), vol 30, Sept 1984, p. 213-224 refs

Features of the GATEP aircraft preliminary design code, which permits user intervention at any point in the execution of the program, are described GATEP (general aviation, twin-engine, propeller driven) is a modular program covering parametric studies, mass, aerodynamics, range, speed, fuel efficiency, and powerplant requirements The mass estimation allows for analyses of wing variations Take-off, landing strip length, and cruise and range performances can be simulated. Sample calculations are provided for a 34-seat, twin-turboprop commuter aircraft and compared with an existing aircraft The accuracy of the results is high enough to commend the program for estimating the effects of design trade-offs  
M.S.K.

### A85-17244

#### 1984 SAE AEROSPACE HANDBOOK: AIR TRANSPORT CABIN AND FLIGHT DECK SAFETY PROVISIONS

Warrendale, PA, Society of Automotive Engineers, Inc., 1984, 479 p. refs

The present compilation of standards, recommended practices and information reports for both civil and military air transport cabin and flight deck safety covers carbon monoxide detection, aircraft circuit breakers and fuses, passageway door operation, emergency equipment storage, passenger evacuation devices, evacuation slide/raft equipment, fire detection instruments and fire extinguishers, galley system specifications, impact protection design for occupants, and lavatory installations Also covered are survival kits, emergency illumination, ozone problems at high altitudes, restraint devices for infants and children, flight deck seating, flight deck doors, oxygen equipment for high altitude commercial aircraft, oxygen flow regulation, parachute assembly standards, and passenger seat design criteria  
O.C.

### A85-17245

#### 1984 SAE AEROSPACE HANDBOOK: NOISE

Warrendale, PA, Society of Automotive Engineers, Inc., 1984, 455 p. refs

Noise emissions from aircraft and their measurement are examined in a collection of information reports and recommended practices Topics treated include acoustic effects produced by a reflecting plane, methods for comparing takeoff and approach noises, predicting lateral attenuation of takeoff and landing noise, exterior noise measurement, noise produced by auxiliary power units and associated equipment, predicting near-field and far-field propeller noise, and an indoor method for collecting and presenting bare-turboshaft engine noise for helicopter installations. Extensive tables, graphs, and diagrams are provided  
T.K.

### A85-17246

#### 1984 SAE AEROSPACE HANDBOOK - LIGHTING

Warrendale, PA, Society of Automotive Engineers, Inc., 1984, 274 p. refs

Interior and exterior lighting equipment for civil and military aircraft is reviewed in a collection of information reports, recommended practices, and standards Topics covered include position and anticollision lights, flashtube anticollision-light systems, cargo-compartment lighting, emergency-evacuation illumination, emergency placarding, galley lighting, indicating systems, instrument and cockpit illumination for general-aviation aircraft, aircraft control knobs, landing and taxiing lights, plastic integrally lighted panels, aerial-refueling lights, visibility of navigation lights, crew-station lighting for commercial aircraft, passenger reading

lights, and flight-deck (visual, audible, and tactile) signals. Graphs, diagrams, and tables are provided.  
T.K.

### A85-17247

#### 1984 SAE AEROSPACE HANDBOOK: ELECTROMAGNETIC COMPATIBILITY

Warrendale, PA, Society of Automotive Engineers, Inc., 1984, 184 p. refs

The electromagnetic compatibility (EMC) of aircraft systems is reviewed in a collection of information reports and recommended practices Graphs, diagrams, and tables of numerical data are provided Topics examined include EMC antennas and antenna factors, cabling guidelines, a 10-mF capacitor for electromagnetic-interference (EMI) measurements, corrosion control and electrical conductivity in enclosure design, dc resistivity versus RF impedance of EMI gaskets, EMC of gas-turbine engines, calibration requirements and techniques for EMI-measurement impulse generators, conventional EMI-reduction filters, a coaxial test procedure for RF shielding of EMI gasket materials, lightning protection and static electrification, and a parallel-plate transmission line for EMI-susceptibility testing.  
T.K.

### A85-17324

#### ELECTRONIC CONTROL AND MONITORING OF AIRCRAFT SECONDARY FLYING CONTROLS

B FARLEY (Dowty Rotol, Ltd, Gloucester, England) Aircraft Engineering (ISSN 0002-2667), vol. 56, Nov. 1984, p. 2-10.

The application of electronics to control and monitor wing trailing edge flap high lift actuation systems is discussed. The resulting equipment has been described and the two systems, one for the British Aerospace 146 aircraft (B Ae 146) and the other for the Casa Nurtanio CN235 aircraft, have been compared for complexity, type of electronic architecture, and reliability. The flap actuation system for the B.Ae 146 provides accurate positional control, high operational reliability and failsafe characteristics, while the simpler CN 235 system has the better mean time between failures and reduced weight The flap system operational reliability requirements effect the design of the equipment, its electronic control system and the degree of circuit complexity. The requirements can be quantified numerically by relating the different types of potential failures of the system with their effect on the handling of the aircraft. A series of schematic diagrams help explain the problems.  
M.D.

### A85-17325

#### A RANGE FOR ALL NEEDS

T FORD Aircraft Engineering (ISSN 0002-2667), vol. 56, Nov. 1984, p. 12-15.

The development and progress of Airbus Industrie aircraft are examined The A310 aircraft, a variant of the basic A300 aircraft and equipped with a new style cockpit, is considered. Its features include an increased cargo capacity and a flight deck with CRT display technology which involves an electronic flight instrument system (EFIS) and an electronic centralized aircraft monitor (ECAM) A combination of ranges up to 6,400 km, offered by the A310-200 and the A300-600, is complemented by the A310-300, developed for ranges of up to 8,500 km. The A320 carries 164 passengers over a range of 2,000 n miles; and with V2500 engines of 25,000 lb thrust, it burns 50 percent less fuel per seat than the trijets now in service Advances in design have resulted in savings in weight, obtained by the use of a CFRP fin, and improved passenger comfort with the addition of extra seats.  
M.D.

**A85-17830#****EFFECT OF PRECIPITATION STATIC ON GENERAL AVIATION DIGITAL AVIONICS**

L O HENDRY (Beech Aircraft Corp., Military Aircraft Group, Wichita, KS) IN Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings New York, American Institute of Aeronautics and Astronautics, 1984, p 190-192.

(AIAA PAPER 84-2641)

Design recommendations were made after a series of tests on the effects of precipitation (P-) static on general aviation electronic avionics. P-static arises from the fields produced by lightning, and was simulated by placing an aircraft in a high voltage (HV) facility. A HV cable was attached to one end of the aircraft, the other was attached to a grounding sphere which was moved around while various electrical systems were activated and monitored. Attention was also given to the occurrence of corona discharges. The tests revealed the need for static dischargers, which would remain closed with a current of 300 A, for the engines. Closed wheel doors were of great aid in assuring a uniform distribution of induced voltage around the aircraft. Conductive coatings were found necessary for all sharp extremities and nonconductive materials.

M S K

**A85-17893#****THE DE-JA VU OF ALL ELECTRIC/ALL DIGITAL AIRCRAFT**

M. J. CRONIN (Lockheed-California Co., Burbank, CA) IN Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings New York, American Institute of Aeronautics and Astronautics, 1984, p. 606-614 refs

(AIAA PAPER 84-2739)

Various aspects of an Integrated Digital Electric Aircraft (IDEA) and ALTERNATE IDEA studies, initiated by NASA, are updated in view of their feasibility and benefits. The IDEA concept incorporates all electric secondary power systems (SPS), Advanced Digital Flight Control System (ADFCS), and electric starting. ALTERNATE IDEA is its advanced version. Among the topics discussed are flight control technology, engine power extraction sensitivities, environmental control systems, electromechanical actuation systems (design/performance data are provided), and electric power systems. The ALTERNATE IDEA concept is noted to allow a reduction in structural load limits from the conventional load factor of 2.5 to 2.0 or 1.5, yielding an 8 percent fuel reduction. The major weight savings for the IDEA concept are shown to be 7034 lb for a Boeing 767-type aircraft.

L T

**A85-17894#****AN ASSESSMENT OF THE 1990 DIGITAL/ELECTRIC AIRPLANE**

G. E. TAGGE (Boeing Commercial Airplane Co., Seattle, WA) IN Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings New York, American Institute of Aeronautics and Astronautics, 1984, p 615-618 refs

(AIAA PAPER 84-2740)

The results of a critical evaluation of the application of advanced digital/electric technologies to commercial aircraft design are presented. The criteria used in the evaluation included five areas for improving fuel efficiency and reducing direct operating costs (DOCs). The specific technologies investigated were: active controls; energy efficient (E3) engines, an advanced supercritical wing design, and composite structures. A conventional baseline configuration incorporating the technologies was compared to a similarly equipped turboprop configuration in terms of weight, survivability, reliability, maintainability and environmental constraints. It is estimated that by 1990 the baseline configuration could achieve a 1.8 percent improvement in DOC and a three percent improvement in fuel burn performance if digital/electric technologies are exploited. For the advanced turboprop configuration DOC and fuel burn efficiency savings were 8.2 percent and 26 percent, respectively.

I H

**A85-18116****LONG-ENDURANCE DRONES MATURE**

Flight International (ISSN 0015-3710), vol 126, Dec 8, 1984, p. 1567-1569

Attention is given to the design features and prospective performance levels of a novel class of RPVs, known as Very Long Endurance Aircraft (VLEAs). Characteristic of VLEAs will be the NASA solar cell/fuel cell-propelled, 235-ft span flying wing, and the CO2 Observational Platform System, which will be powered by a ground-based microwave transmitter and will have a mission endurance of six months. Military VLEAs are under consideration for airborne aircraft and missile detection and other high altitude surveillance tasks. VLEA requirements for airframe structure, electromechanical propulsion systems, remote control, and solar cell energy collection and storage, are discussed.

O.C

**A85-18117****CANADAIR 601 - CHALLENGER IN NAME AND IN PERFORMANCE**

H HOPKINS Flight International (ISSN 0015-3710), vol 126, Dec 8, 1984, p. 1572-1578

Attention is given to the design features, cabin appointments, performance levels, and flight characteristics of the Challenger CL-601 executive aircraft, which is propelled by two 63:1-bypass ratio, 9000-lb takeoff thrust turbofans. A cutaway drawing of the aircraft is presented, and a detailed evaluation is made of takeoff and climb, cruise, and landing characteristics, as well as cockpit instrumentation features and mechanical subsystem functioning. A tabular comparison is made of CL-601 cabin dimensions, weights, and range and speed performance, with its primary competitors in the executive jet market; these include the Gulfstream GIII and GIV, and the Falcon 50 and 900.

O.C

**A85-18149****ENVIRONMENTAL ENGINEERING AT SAAB-SCANIA AIRCRAFT DIVISION**

S E PALGARD (Saab-Scania AB, Linköping, Sweden) (Institute of Environmental Sciences, Annual Technical Meeting, 30th, Orlando, FL, May 1984) Journal of Environmental Sciences (ISSN 0022-0906), vol 27, Nov-Dec 1984, p 43-45

An organizational scheme for the environmental engineering activities of an aerospace company is described. The scheme is applied to the study of technical solutions to the problems of gunfire vibration and cabin noise in propeller aircraft. Emphasis is given to the role of cooperation between different organizational bodies in the identification of test methodology.

I.H

**A85-18327#****ZERO-TH-ORDER FEEDBACK STRATEGIES FOR MEDIUM-RANGE INTERCEPTION IN A HORIZONTAL PLANE**

J SHINAR (Technion - Israel Institute of Technology, Haifa, Israel) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 8, Jan-Feb 1984, p 9-15 refs

A zeroth-order feedback solution of a variable-speed interception game between two aircraft in the horizontal plane, obtained by using the method of forced singular perturbations, is compared with the exact open-loop solution. The comparison indicates that the forced singular-perturbation approximation, based on multiple time-scale separation of the state variables, is satisfactory. Nevertheless, in cases where the interception terminates at speeds much lower than the maximum speed predicted by the reduced-order game, a rough estimate of these final speeds is needed to improve the accuracy. Using such estimates, a payoff error of 1 percent or less is demonstrated in all examples with sufficiently large initial distances of separation (greater than 6-8 times the best initial turning radius of the pursuer). The results validate the zeroth-order forced singular-perturbation approximation for medium-range air combat analysis. This explicit feedback strategy is a very attractive candidate for airborne implementation.

Author



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**A85-18328#**

### **FOUR-DIMENSIONAL FUEL-OPTIMAL GUIDANCE IN THE PRESENCE OF WINDS**

A CHAKRAVARTY (Boeing Commercial Airplane Co., Seattle, WA) (Guidance and Control Conference, Gatlinburg, TN, August 15-17, 1983, Collection of Technical Papers, p 584-593) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol 8, Jan-Feb 1984, p 16-22 Previously cited in issue 19, p 2796, Accession no A83-41719 refs

**A85-18329\*#** Stanford Univ., Calif

### **INTERCEPTION IN THREE DIMENSIONS - AN ENERGY FORMULATION**

N RAJAN (Stanford University, Stanford, CA) and M. D ARDEMA (NASA, Ames Research Center, Moffett Field, CA) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol 8, Jan-Feb. 1984, p 23-30 Previously cited in issue 19, p. 2798, Accession no A83-41946 refs

**A85-18330#**

### **PERIODIC OPTICAL CRUISE OF AN ATMOSPHERIC VEHICLE**

J L SPEYER, D DANNEMILLER, and D WALKER (Texas, University, Austin, TX) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol 8, Jan-Feb 1984, p 31-38 refs (Contract NSF ECS-79-18246)

Since the steady-state cruise path of an idealized point mass model of an atmospheric vehicle operating in the hypersonic flight regime is dynamically not fuel minimizing, closed periodic paths are numerically determined. By application of second-order conditions for local optimality, a periodic extremal path for a flat earth is shown to be locally minimizing and produces an improvement in fuel usage of 4.2 percent over the steady-state cruise path. Application of these second variational conditions to extremal paths for the spherical earth failed. Nevertheless, these paths produce improved fuel performance over the associated steady-state cruise path. Author

**A85-18348#**

### **ISOCHRONES FOR MAXIMUM ENDURANCE HORIZONTAL GLIDING FLIGHT**

J-S CHERN (Chung Shan Institute of Science and Technology, Lungtan, Republic of China) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 8, Jan-Feb 1984, p 148-150. refs

Williamson (1979, 1980) and Vinh et al (1984) have studied the problem of maximum endurance gliding flight in a horizontal plane, exemplified by a small lifting vehicle capable of carrying a weapon system and gliding in a horizontal plane at a certain low altitude. The most general form of this problem involves the specification of the target position within the reachable zone and the subsequent solution for the maximum endurance trajectory. The present investigation is concerned with obtaining the complete solution of this case, taking into account the presentation of the isochrones in the (psi-0,x-t) space. G.R

**A85-18441#**

### **DESIGNING A CRUISE MISSILE - GENERAL DYNAMICS' BGM-109 TOMAHAWK**

R. DEMEIS Aerospace America (ISSN 0740-722X), vol. 23, Jan 1985, p 110-112, 114

Functional and performance features chosen for the Tomahawk cruise missile (TCM) are reported. The missile is intended for launch from aircraft, shipboard, land vehicles or from submarine torpedo tubes. The latter provided the most difficult design problems. The length of the TCM was limited to that of a torpedo length. Stainless steel containers hold the aluminum TCMs before launch, which is effected by water pressure at the rear of the missile. The casing is expelled from the launch tube after the TCM. A solid rocket booster ignites in the water and carries the TCM into the atmosphere, where the booster and shrouds over the turbofan inlet and folded winglets are jettisoned. The TCM then cruises at 200 ft altitude and Mach 0.7, guided by radar altimeter data and an electronically stored map. The nuclear

warhead and electronics are cooled by the flow of TH-dimer fuel. M S K.

**A85-18472**

### **U-2R, TR-1 - LOCKHEED'S BLACK LADIES**

J MILLER Air International (ISSN 0306-5634), vol 27, Oct. 1984, p 185-190, 203-208

After recounting the development history and operational achievements of the U-2 high altitude reconnaissance aircraft, attention is given to the design features and performance characteristics of its U-2R and TR-1 derivatives, which incorporate supercritical wing airfoil sections, increased wing area, an enlarged fuselage with greater internal volume for sensor and ECM payloads, and greatly increased fuel capacity. The 11,735-liter fuel load carried internally allows mission durations in excess of 15 h. The TR-1 is a modification of the U-2R which incorporates an advanced synthetic aperture radar and a side-looking airborne radar with a range of more than 80 km. O C.

**A85-18518#**

### **ECONOMICAL INFLUENCE FUNCTION CALIBRATIONS USING THE DISTRIBUTED LOADS CODE**

K. S. KEEN (Calspan Field Services, Inc., Arnold Air Force Station, TN) Journal of Aircraft (ISSN 0021-8669), vol. 22, Jan 1985, p 85-87 refs

The difficulty and expense of obtaining force, moment, and local angle-of-attack distributions have been the major limitations of the Influence Function Method for the prediction of store loads within an aircraft interference field. The Interference Distributed Loads (IDL) code has been modified to predict store force and moment coefficients along an axial traverse through a simple calibration flowfield. IDL predictions were made for both generic planar wing weapon and the GBU-15 bomb stores, in the case of an F-15 pylon flowfield, and accurate grid predictions were obtained. O C.

**A85-18520#**

### **DETERMINATION OF SUBCRITICAL DAMPING IN CF-5 FLIGHT FLUTTER TESTS**

B H K LEE (National Aeronautical Establishment, Ottawa, Canada) Journal of Aircraft (ISSN 0021-8669), vol. 22, Jan. 1985, p 89-91. Research supported by the Department of National Defence

The use of raps on the joystick of a CF-5 aircraft undergoing flight flutter tests can easily and effectively excite vibration modes. Spectral analysis of the elevator and aileron pulses indicate that the time histories of the displacements can be represented by exponential cosine functions. Damping results obtained from an impulse representation of the lift and moment generated by stick raps may be very different from those using an exponential cosine function representation. O.C.

**A85-18610**

### **MODIFYING AND TESTING A CANARD ON A SWISS MIRAGE III - FLIGHT TEST STATUS REPORT**

W SPYCHIGER (Swiss Defence Technology and Procurement Agency, Switzerland) Cockpit (ISSN 0742-1508), vol 19, July-Sept 1984, p. 5-12.

The Swiss Defence Technology and Procurement Agency has undertaken the modification of the Mirage III fighter with a canard control system, in order to increase lift and maneuverability. In doing so, an attempt was made to arrive at a canard configuration which would minimize both the costs and the refitting time required for the Swiss Mirage III fleet. In the ensuing flight test program, attention was given to the retrofitted systems' aft center of gravity for cruising flight and dogfighting regimes, the maximum angle of attack achievable, and the effect of the system on engine envelope, gun firing and Sidewinder missile separation. O.C.

**A85-18713**  
**IN-FLIGHT SIMULATION IN FLIGHT MECHANICS**  
**[IN-FLIGHT-SIMULATION IN DER FLUGMECHANIK]**

D HANKE (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Institut fuer Flugmechanik, Brunswick, West Germany) DFVLR-Nachrichten (ISSN 0011-4901), vol 43, Nov 1984, p. 5-11 In German

Requirements for the improvement of aircraft have led to the employment of simulation installations in aviation-related research. An important position is occupied by in-flight simulators provided by aircraft with variable flight characteristics. The in-flight simulators are well suited for a study of problems which are concerned with the complex interaction between pilot and aircraft system. Problems related to the optimization and evaluation of the entire system require for their solution comprehensive simulations on the ground or flight tests involving the participation of the pilot. In addition, a flying simulation device makes it possible to test new technologies in a flight test without risk, under real operational conditions. The application range of in-flight simulators includes the development of new steering and control concepts, and the development of advanced cockpit design and system integration approaches. Attention is given to the principles of in-flight simulation, the Airbus simulation with the HFB 320, and future developments related to in-flight simulators. G.R

**A85-18725**  
**25,000 FLIGHT HOURS IN THE ALPHA JET BY THE 8TH CHASE SQUADRON. I [25,000 HEURES DE VOL SUR ALPHA JET A LA 8E E.C. I]**

J DE GALARD Air et Cosmos (ISSN 0044-6971), vol 22, Dec 15, 1984, p. 40, 41, 52 In French.

The 8th chase squadron of the French Air Force is the last training school for pilots before entering operational duty. The 13,500 lb thrust Alpha jet has been used for training flights since 1982. The jet has now totaled nearly 300,000 cumulative flight hours, 25,000 with the 8th squadron. The distribution of the instructional and solo flight hours (the Alpha jet has two seats) is detailed, noting that a move is gaining momentum to increase the number of solo hours as a confidence builder for the young pilots. The trainer can be equipped with a nose cannon or bombs for practice attacks, although flight instruction is directed mainly toward air maneuvers, as is necessary for a chase pilot. M.S.K

**A85-18773#**  
**DYNAMICS OF A HELICOPTER ROTOR IN ABNORMAL OPERATING CONDITIONS [DYNAMIKA WIRNIKA SMIGLOWCA W WARUNKACH TRANSGRESJI UKLADU]**

K SZUMANSKI Instytut Lotnictwa, Prace (ISSN 0509-6669), no 96, 1984, p. 19-80 In Polish refs

Results of simulation analysis are examined for dynamic problems of a helicopter rotor under limiting conditions of the operation of system components. Aeroelastic phenomena occurring if the aeroelastic stability limit of the rotor has been exceeded are investigated, including classical flutter, blade divergence, flow separation flutter, and compressibility flutter. Also considered is the problem of rotor dynamics if admissible control limits have been exceeded (rough control or pull-up) or under abnormal flying conditions (e.g., intense turbulence). Finally, attention is given to the assessment of the effect of unconventional rotor design on the processes considered, under abnormal operating conditions. The examples discussed are hingeless rotors and aeroelastic rotors with soft, highly deformable blades of ACR type. B.J

**A85-18804**  
**COMPUTER GEOMETRIC SIMULATION OF CRUISE MISSILE CENTER OF GRAVITY VERSUS FUEL CONSUMPTION**

A. M. PRAST (General Dynamics Corp., Convair Div., San Diego, CA) Society of Allied Weight Engineers, Annual Conference, 42nd, Anaheim, CA, May 23-25, 1983, 5 p (SAWE PAPER 1511)

The tank drain simulation program was developed to compute the center of gravity (COG) of a cruise missile in-flight as fuel is consumed. Account is taken of internal tank geometries, which

are described in FORTRAN IV code, and the fuel tank volume. The user can test the effects of varying the number of fuel tanks on the flight stability as the COG shifts. The flight angle is determined up to 15 deg pitch up or down from the horizontal and is calculated for each position of the COG. A time-of-flight history of both values, and the fuel head, is generated. M.S.K.

**A85-18808**  
**WEIGHT-ASPECTS OF THE ADVANCED COMPOSITE AIRFRAME PROGRAM (ACAP)**

W. H. MARR (U.S. Army, Applied Technology Laboratory, Fort Eustis, VA) and J. G. SUTTON (Sikorsky Aircraft, Stratford, CT) Society of Allied Weight Engineers, Annual Conference, 42nd, Anaheim, CA, May 23-25, 1983, 26 p (SAWE PAPER 1517)

Results to date from Sikorsky's participation in the Army's advanced composite airframe program (ACAP) are reported. ACAP was initiated to derive lighter, higher performance helicopters which could carry heavier payloads for greater distances. Design criteria for the structural components included a ballistic tolerance equal to or surpassing usual material, survival of a 42 fps vertical drop, and a 20 percent reduction in reliability and maintenance costs. The helicopter was required to weigh under 5 tons, carry two crew side-by-side, fly for 2.3 hr, and hover at 2000 ft in 95 F heat. A chief goal of ACAP is to encourage manufacturers to demonstrate the capabilities for producing the composite structures. An S-76 helicopter was fitted with 24 percent composite parts compared to its commercial counterpart. The part count was thereby lowered by 60 percent, the crashworthiness of the UH-60 was exceeded, a 22 percent weight savings was realized, and the cost of the helicopter was 17 percent less. M.S.K.

**A85-18809**  
**UNIQUE WEIGHT AND BALANCE ASPECTS OF V/STOL AIRPLANE DESIGN**

T. J. GRAHAM (McDonnell Aircraft Co., St. Louis, MO) Society of Allied Weight Engineers, Annual Conference, 42nd, Anaheim, CA, May 23-25, 1983, 16 p (SAWE PAPER 1518)

Design considerations for V/STOL propulsion requirements are discussed. Vectored thrust with rotating nozzles has been identified as the most effective system and has been incorporated in the Harrier fighters, which can fly at slow and zero cruise speeds. Engine bleed air is directed through the nose, tail and wingtips, which serve as the reaction control system to attain stability when there is no flow across the lifting surfaces. The additional ducting and larger engine associated with the enhanced airborne capabilities lower the thrust/weight ratio of V/STOL aircraft. Plenum chamber burning, i.e., augmenting engine thrust by burning the fan bypass air, is being explored to push the Harrier to supersonic speeds. Center of gravity and center of thrust problems with the Harrier led to installation of the engine environmental control avionics aft and the engine in the center of the aircraft. M.S.K.

**A85-18813**  
**GLASSWIND GEMINI - THE NEXT STEP**

J. HUTTON (Boeing Commercial Airplane Co., Seattle, WA) Society of Allied Weight Engineers, Annual Conference, 42nd, Anaheim, CA, May 23-25, 1983, 17 p (SAWE PAPER 1528)

Choices made in the process of producing a design for a two-person aircraft that would weigh no more than 350 lb are discussed. Side-by-side seating near the wing center of lift eliminated ballast requirements. One engine was placed in the nose and another in a pylon on the aft fuselage, thereby providing a twin engine aircraft without a twin rating. Gull-wing doors and a semi-supine pilot position allowed easy access and room in the aircraft. The aircraft was made amenable to towing on a trailer by installing a joint near the wing roots, which were reinforced and serve as steps for pilot entrance. A 13 percent thickness, GA(W)-2 airfoil was selected, along with a large enough horizontal tail to assure good stability and control with failure of either 25 hp engine. The body and wings were constructed of Kevlar-coated foam core.

## 05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

panels It is expected that the aircraft, the Gemini, will be certified and plans will be available for home construction by 1985

M.S.K

### A85-18814

#### A SURVEY OF REPORTED WEIGHT AND COST SAVINGS FOR COMPOSITE VS. METAL AIRFRAMES

R L FOYE (U.S. Naval Postgraduate School, Monterey, CA) Society of Allied Weight Engineers, Annual Conference, 42nd, Anaheim, CA, May 23-25, 1983 19 p (SAWE PAPER 1547)

The impact new structural composites are having on manufacturing cost and the structural weight of airframes is surveyed. The study covers over 500 aerospace company programs and most aircraft structures built since the late 1960s, and comparisons are made with the costs and weights of metal components Attention is given to rotor blades and hubs, transmissions and gearboxes, drive shafts, propellers, fuselages, cockpits, cabins, tail cones, etc No trend was seen toward lower composite weights since their introduction, and no composite was found to have a typical weight Weight savings, compared to metals, range from 0-30 percent and costs are lower by 0-40 percent The greatest cost savings are expected from main rotor hubs and fuselages.

M.S.K.

### A85-18815

#### COST AND WEIGHT ESTIMATING CONSIDERATIONS FOR TRANSPORT AIRCRAFT SYSTEM INSTALLATIONS

D. P. MARSH (Douglas Aircraft Co., Long Beach, CA) Society of Allied Weight Engineers, Annual Conference, 42nd, Anaheim, CA, May 23-25, 1983 33 p (SAWE PAPER 1548)

A manufacturing cost estimation relationship for aircraft pneumatic duct installation is presented which gives some considerations to weight and parts counts The method was defined after a study of 60 different duct assemblies Account was taken of set-up, fabrication, material, spare parts, service bulletin costs, installation costs and correlations between the factors Attention was directed separately to aluminum and steel ducts Parts count was found to dominate over weight as a cost driver, and could be influenced by the size of the assembly when installation costs are significant

M.S.K

### A85-18819

#### IMPACT OF MIL-STD-1290 CRASHWORTHINESS REQUIREMENTS ON DESIGN OF HELICOPTER COMPOSITE STRUCTURES

J D. CRONKHITE (Bell Helicopter Textron, Fort Worth, TX) Society of Allied Weight Engineers, Annual Conference, 42nd, Anaheim, CA, May 23-25, 1983 26 p FAA-supported research. refs

(Contract DAAK51-79-C-0037)

(SAWE PAPER 1567)

The results of an R&D program devised to identify methods and concepts for the design of composite airframe structures which satisfy Mil-Spec 1290 crashworthiness criteria are reported The effort included construction of two full-scale composite helicopter cabin sections, predicting their response to an impact using the KRASH program and comparing the model predictions with simulated crashes The cabins incorporated several energy-absorbing structural design features which were tested in the 30 fps drop and 20 deg roll tests. The trials underscored the necessity of providing an energy-absorption and load attenuation primary protective shell structure around the cabin occupants The subfloor supports could be added without producing weight problems because of the lighter weight of the composites

M.S.K

### A85-18820

#### MINIMUM AND MAXIMUM CARGO TABLES FOR AIRCRAFT WITH THREE CARGO COMPARTMENTS

T L TOOGOOD (Douglas Aircraft Co., Long Beach, CA) Society of Allied Weight Engineers, Annual Conference, 42nd, Anaheim, CA, May 23-25, 1983 11 p (SAWE PAPER 1568)

This paper presents a procedure for calculating minimum and maximum cargo weights for aircraft with three cargo compartments For a given number of passengers and a given amount of cargo, this procedure distributes the cargo load to each of three compartments in such a manner that the balance limits are never exceeded. A mathematical analysis is used to determine the intersection of the cargo vectors One compartment is limited to a constant load by volume or structural limits while the quantities in the other two are determined

Author

### A85-18821

#### ESSENTIAL DESIGN FEATURES OF A310

W. D. WISSEL (Airbus Industrie, Toulouse, France) Society of Allied Weight Engineers, Annual Conference, 42nd, Anaheim, CA, May 23-25, 1983 20 p. refs (SAWE PAPER 1569)

Structural technology advances made and planned for the Airbus A310 transport aircraft are described The components were chosen for lightweight characteristics, which improve the fuel economy Superplastic forming and diffusion bonding processes were employed with Ti and Al alloys for the fuel tanks and wing slats. The components were either male, female or plug formed with air blowing into a matrix holding Ti material The fin box was constructed of carbon fiber composite material by an automated process. More than 260 equally sized modular pieces made up the fin, which was wrapped in a prepreg and stiffened with unidirectional tapes. Stiffened web CFRP material was also employed for the ribs and spars The structural and environmental testing procedures are outlined The materials are projected to save 4300 gal of fuel per aircraft per year, and manufacturing costs are reduced by automation.

M.S.K

### A85-18822

#### BOEING 757-200 DEVELOPMENT AND THE CONTRIBUTION OF WEIGHT AND BALANCE CONTROL

I. M. MCINTOSH (Boeing Commercial Airplane Co., Seattle, WA) Society of Allied Weight Engineers, Annual Conference, 42nd, Anaheim, CA, May 23-25, 1983 21 p (SAWE PAPER 1570)

Design efforts and results from the development of the 757-200 transport aircraft center of gravity envelope are reported. A strong weight and balance control plan was instituted at the onset of the program The 727-200 body and tail sections were employed with a new aft body and tail The wings were built with 7 deg less sweep than the 727 and more span thickness, which improved the L/D ratio. Installation of RB211-534E or PW2037 engines, an optional choice for the purchaser, offers a 27 percent improvement in fuel efficiency. Advanced aluminum alloys and composite secondary structures have provided several thousand pounds of weight savings Weight status review meetings were held throughout the development program and featured reports from weight engineers on each design team Any weight changes recommended were subjected first to a costs review and alternatives studies. The program yielded a 4300 lb net reduction over the baseline design, while keeping the center of gravity within tight limits for all planned variants of the aircraft.

M.S.K.

### A85-18823

#### 757 PAYLOADS WEIGHT OPTIMIZATION

R. L. ANDERSON (Boeing Commercial Airplane Co., Seattle, WA) Society of Allied Weight Engineers, Annual Conference, 42nd, Anaheim, CA, May 23-25, 1983 24 p. (SAWE PAPER 1571)

Measures implemented in carrying out the weight reduction program during the design of the 757 interior are described. Weight savings were realized in the ceiling/sidewall lining and lighting,

acoustic insulation, stowage, partitions, seats and carpet, galleys, water supplies and service units, emergency equipment, and the cargo compartment. A 19 percent reduction in the design justification weight was achieved, representing over 3200 lb. The major savings came in the window panels, overhead stowage installation, conditioned air outlet extrusion, and the cargo lining installation. Kevlar, Tedlar, and graphite composites replaced former fiberglass materials in many places where feasible and cost-effective. It was found that direct participation in design decisions by the weight reduction program manager was mandatory for achieving the program's success M.S.K.

**N85-13795#** Centre d'Essais en Vol, Istres (France). Base d'Essais  
**THE DG400 PROPULSED GLIDER [PLANEUR PROPULSE DG 400]**

12 Sep 1984 63 p refs In FRENCH  
 (CEV/IS/SE/AV/84) Avail: NTIS HC A04/MF A01

Test results of a Glaser-Dirks glider are presented. The aircraft has 15 m wingspan, weighs 300 Kg and has a 32 kW internal combustion motor. The flight tests included 19 flights and 27 hr total flight time. The generally positive results assure a recommendation for DG400 certification Author (ESA)

**N85-14816\*#** Sperry Rand Corp., Blue Bell, Pa  
**INTEGRATED COCKPIT DESIGN FOR THE ARMY HELICOPTER IMPROVEMENT PROGRAM**

T. DRENNEN and B. BOWEN (Textron Bell Helicopter, Fort Worth, Tex.) In NASA Ames Research Center Technical Workshop Advanced Helicopter Cockpit Design Concepts p 121-144 Dec 1984

Avail: NTIS HC A15/MF A01 CSCL 01C

The main Army Helicopter Improvement Program (AHIP) mission is to navigate precisely, locate targets accurately, communicate their position to other battlefield elements, and to designate them for laser guided weapons. The onboard navigation and mast-mounted sight (MMS) avionics enable accurate tracking of current aircraft position and subsequent target location. The AHIP crewstation development was based on extensive mission/task analysis, function allocation, total system design, and test and verification. The avionics requirements to meet the mission was limited by the existing aircraft structural and performance characteristics and resultant space, weight, and power restrictions. These limitations and night operations requirement led to the use of night vision goggles. The combination of these requirements and limitations dictated an integrated control/display approach using multifunction displays and controls B.G.

**N85-14817\*#** International Business Machines Corp., Owego, N.Y.

**HH-60D NIGHT HAWK HELICOPTER**

C. S. RICHARDSON In NASA Ames Research Center Technical Workshop Advanced Helicopter Cockpit Design Concepts p 145-164 Dec 1984

Avail: NTIS HC A15/MF A01 CSCL 01C

Fundamental development issues, system requirements and improvements are reported for the HH-60D night hawk helicopter. The HH-60D mission requirements are for combat search and rescue (aerospace rescue and recovery service user based at Scott AFB) and special operations (special operations forces based at Hurlburt AFB). Cockpit design, computer architecture and software are described in detail B.W.

**N85-14823\*#** National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

**OPERATIONAL REQUIREMENTS - SYSTEM CONCEPTS**

J. W. VOORHEES and H. L. SNYDER In its Technical Workshop Advanced Helicopter Cockpit Design Concepts p 229-238 Dec 1984

Avail: NTIS HC A15/MF A01 CSCL 01C

Nine research areas that are most critical to the issue of cockpits for the single pilot are discussed. Helicopter are addressed in this report. They are as follows: (1) automation priority issues, (2)

increased complexity of systems, (3) cockpit workload highest in navigation, (4) auto hover and flight trim controls; (5) voice technology in integrated form; (6) systems must have visual and auditory declutter modes, (7) cockpit should be designed to be NBC resistant, and (8) considerations for spillover to civilian public service. B.W.

**N85-14826\*#** Textron Bell Helicopter, Fort Worth, Tex.

**ATTACK HELICOPTER (AH-1T) COCKPIT SYSTEMS INTEGRATION**

V. A. GRAF In NASA Ames Research Center Technical Workshop Advanced Helicopter Cockpit Design Concepts p 271-316 Dec 1984 refs

Avail: NTIS HC A15/MF A01 CSCL 01C

This discussion summarizes the effort conducted by the BHTI Human Factors and Cockpit Arrangement group for a study and design of the integration of a cockpit control system for the AH 1T (TOW). The resulting design is a culmination of studies that were conducted using the existing configuration as a baseline and complementing it with new equipment and subsystems that fulfill the attack helicopter requirements for the foreseeable future. Of primary concern was the requirement to add a missile control system, with secondary considerations for improved NOE and night operations. In addition, growth capabilities for improved target acquisition, weapons delivery, and precise navigation was considered. Along with the addition of new equipment, the aircraft was assumed to have a central multiplex data bus system for information transfer throughout the aircraft and its subsystems. B.W.

**N85-14833\*#** National Aeronautics and Space Administration, Langley Research Center, Hampton, Va.

**FLIGHT TEST TECHNIQUE FOR EVALUATION OF GUST LOAD ALLEVIATION ANALYSIS METHODOLOGY**

B. PERRY, III Dec 1984 22 p refs Presented at the Aeroservoelasticity Tech Spec Meeting, Wright-Patterson AFB, Ohio, 2 Oct - 4 Oct 1984

(NASA-TM-86344, NAS 1 15 86344) Avail: NTIS HC A02/MF A01 CSCL 01C

A technique for gust load alleviation (GLA) flight testing that will approximate a turbulence-like excitation of the wing has been devised. An artificial excitation is produced by randomly deflecting inboard control surfaces on the wing, thereby producing incremental loads on the wing. This presentation covers the background and development of the flight test technique and analyses performed to date B.W.

**N85-14834#** National Aerospace Lab., Tokyo (Japan)

**A THEORETICAL DESIGN METHOD FOR 3-DIMENSIONAL TRANSONIC WINGS**

S. TAKANASHI Aug 1984 16 p refs In JAPANESE; ENGLISH summary

(NAL-TR-830, ISSN-0389-4010) Avail: NTIS HC A02/MF A01

A general design method for three-dimensional transonic wings with prescribed pressure distribution is presented. The present approach is based on an iterative residual-correction concept. The residual, defined as the difference between the computed and the prescribed pressure distributions at each iteration step, is determined by the use of an existing direct analysis code for a three-dimensional transonic wing, and the wing surface geometry correction to compensate for the residual can be approximately obtained from the inverse design code developed in the present study. The inverse problem is solved here by the aid of the transonic integral equation method. The most important feature of the present method is that the analysis code is retained in its original form and can be treated solely as a black box. Some of the design results are also presented for a transonic swept wing B.W.

## 05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

### **N85-14835#** National Aerospace Lab, Tokyo (Japan) **FLIGHT TEST RESULTS ON STALL CHARACTERISTICS OF A LARGE JET TRANSPORT**

Y TSUKANO, T ONO, and J KOO Jun. 1984 19 p refs In JAPANESE; ENGLISH summary (NAL-TR-817; ISSN-0389-4010) Avail: NTIS HC A02/MF A01

Flight tests were conducted with a large jet transport airplane to evaluate two techniques for demonstrating the stalling speed: (1) the FAR (Federal Aviation Regulations) demonstration technique, and (2) the flight path 1-G-break technique. Flow separation patterns were observed by tuft survey along the upper surface of the wing during the stall which is defined by each demonstration technique. Based upon the observed flow patterns, the under-lying difference between these techniques were compared and discussed. Author

### **N85-14836\*#** National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif **CLOSING THE DESIGN LOOP ON HIMAT (HIGHLY MANEUVERABLE AIRCRAFT TECHNOLOGY)**

T. W. PUTNAM and M. R. ROBINSON (Rockwell International) Dec 1984 11 p refs Presented at the 14th Congr of the International Council of the Aeronautical Sciences, Toulouse, 9-14 Sep 1984

(NASA-TM-85923, NAS 1 15 85923, NA-84-1893) Avail: NTIS HC A02/MF A01 CSCL 01C

The design methodology used in the HiMAT program and the wind tunnel development activities are discussed. Selected results from the flight test program are presented and the strengths and weaknesses of testing advanced technology vehicles using the RPV concept is examined. The role of simulation on the development of digital flight control systems and in RPV's in particular is emphasized. E A K.

### **N85-14837\*#** Boeing Commercial Airplane Co., Seattle, Wash Preliminary Design Dept

#### **INTEGRATED APPLICATION OF ACTIVE CONTROLS (IAAC) TECHNOLOGY TO AN ADVANCED SUBSONIC TRANSPORT PROJECT. ACT/CONTROL/GUIDANCE SYSTEM STUDY, VOLUME 1 Final Contractor Report, Dec. 1980 - Jan. 1982**

Dec 1982 193 p refs 2 Vol.

(Contract NAS1-15325)

(NASA-CR-165963-VOL-1; NAS 1.26 165963-VOL-1;

D6-51144-VOL-1) Avail: NTIS HC A09/MF A01 CSCL 01C

The active control technology (ACT) control/guidance system task of the integrated application of active controls (IAAC) technology project within the NASA energy efficient transport program was documented. The air traffic environment of navigation and air traffic control systems and procedures were extrapolated. An approach to listing flight functions which will be performed by systems and crew of an ACT configured airplane of the 1990s, and a determination of function criticalities to safety of flight, are the basis of candidate integrated ACT/Control/Guidance System architecture. The system mechanizes five active control functions: pitch augmented stability, angle of attack limiting, lateral/directional augmented stability, gust load alleviation, and maneuver load control. The scope and requirements of a program for simulating the integrated ACT avionics and flight deck system, with pilot in the loop, are defined, system and crew interface elements are simulated, and mechanization is recommended. Relationships between system design and crew roles and procedures are evaluated. E A K.

### **N85-14838\*#** Boeing Commercial Airplane Co., Seattle, Wash Preliminary Design Dept.

#### **INTEGRATED APPLICATION OF ACTIVE CONTROLS (IAAC) TECHNOLOGY TO AN ADVANCED SUBSONIC TRANSPORT PROJECT. ACT/CONTROL/GUIDANCE SYSTEM STUDY. VOLUME 2: APPENDICES Final Contractor Report, Dec. 1980 - Jan. 1982**

Dec 1982 251 p 2 Vol

(Contract NAS1-15325)

(NASA-CR-165963-VOL-2; NAS 1.26 165963-VOL-2,

D6-51144-VOL-2) Avail: NTIS HC A12/MF A01 CSCL 01C

The integrated application of active controls (IAAC) technology to an advanced subsonic transport is reported. Supplementary technical data on the following topics are included: (1) 1990's avionics technology assessment, (2) function criticality assessment, (3) flight deck system for total control and functional features list; (4) criticality and reliability assessment of units, (5) crew procedural function task analysis, and (6) recommendations for simulation mechanization. E A K.

### **N85-14955#** Joint Publications Research Service, Arlington, Va **ITERATIVE METHOD OF CALCULATING STRENGTH OF AIRFRAME MEMBERS USING FINITE ELEMENT METHOD Abstract Only**

S. M. BASTRAKOV, Y. A. DENISOV, and Y. G. POPOV In its USSR Rept. Eng. and Equipment (JPRS-UEQ-84-007) p 1 14 Nov 1984 Transl. into ENGLISH from Izv. Vyssh. Ucheb. Zaved. Aviat. Tekhn. (Kazan), no 4, Oct.-Dec 1983 p 9-14. Avail: NTIS HC A04/MF A01

Problems of deriving the exact solution of systems of linear equations more rapidly for analyzing structures stated nonlinearly are examined, along with aspects of developing the iterative method further. The iterative strength analysis method is extended from the shift method (beam scheme) to the method of forces. Reducing the problem of analyzing airframe members under conditions of physical nonlinearity to matrix manipulation by augmentation during each iteration speeds up the calculation by a factor of 6 to 9 over solutions using other manipulation methods in all stages. Author

### **N85-14956#** Joint Publications Research Service, Arlington, Va **DETERMINATION OF PARAMETERS OF CUPPED AIRCRAFT LANDING SKI Abstract Only**

A. K. CHURUSOV In its USSR Rept. Eng. and Equipment (JPRS-UEQ-84-007) p 1 14 Nov 1984 Transl. into ENGLISH from Izv. Vyssh. Ucheb. Zaved.: Aviat. Tekhn. (Kazan), no 4, Oct.-Dec 1983 p 9-14.

Avail: NTIS HC A04/MF A01

The parameters of cup-shaped circular aircraft landing skis are analyzed. It is found that circular skis provide an effective means for improving aircraft ground mobility. Author

### **N85-14957#** Joint Publications Research Service, Arlington, Va **ANALYTICAL CONSTRUCTION OF FLIGHT VEHICLE SURFACES Abstract Only**

V. F. SNIGIREV In its USSR Rept. Eng. and Equipment (JPRS-UEQ-84-007) p 2 14 Nov. 1984 Transl. into ENGLISH from Izv. Vyssh. Ucheb. Zaved.: Aviat. Tekhn. (Kazan), no 4, Oct.-Dec 1983 p 100-102.

Avail: NTIS HC A04/MF A01

A functional is examined that simplifies the selection of the combined approximating functions on the interpolation node grid to account for arbitrary arrangement of the interpolation nodes. An example is presented to investigate the convergence of a numerical solution of the problem of determining the surface (spline) and parameter  $m(x,y)$ . Author

**N85-14983#** Joint Publications Research Service, Arlington, Va  
**STRENGTH ANALYSIS OF FAN-SHAPED WING CONSIDERING TEMPERATURE DEFORMATION AND CREEP DEFORMATIONS Abstract Only**

Y A. KASHFRAZIYEV *In its* USSR Rept Eng. and Equipment (JPRS-UEQ-84-007) p 45 14 Nov. 1984 Transl into ENGLISH from Izv Vyssh Ucheb Zaved Aviat Tekhn (Kazan), no 4, Oct.-Dec. 1983 p 85-88  
 Avail NTIS HC A04/MF A01

The supporting surface of a flight vehicle with a fan arrangement of the longerons was examined. The stress-strain state of such structures is determined with allowance for the influence of temperature deformations and creep deformations. Creep is found to cause substantial redistribution of stresses in the strength members, as well as the accumulation of residual deformations that can cause premature failure of supporting surfaces E.A.K

**N85-14985#** Joint Publications Research Service, Arlington, Va  
**ANALYSIS OF THIN-WALLED AIRFRAME MEMBERS IN GEOMETRICALLY NONLINEAR STATEMENT Abstract Only**

V. A. PAVLOV and A. S. SAFONOV *In its* USSR Rept Eng. and Equipment (JPRS-UEQ-84-007) p 46 14 Nov. 1984 Transl into ENGLISH from Izv Vyssh Ucheb. Zaved. Aviat Tekhn (Kazan), no. 4, Oct.-Dec. 1983 p 52-56  
 Avail NTIS HC A04/MF A01

A geometrically nonlinear analytical theory is developed that allows the influence of axial shifting on the stress-strain state of a structure to be assessed. A proposed theory is extended to include geometrically nonlinear problems. Nonlinear integral differential matrix equations are derived for determining the stress-strain state of a thin walled structure with allowance for geometric nonlinearity. E.A.K

## 06

## AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices, and flight instruments

**A85-16089#**  
**THE NIGHT VISION GOGGLE COMPATIBLE HELICOPTER COCKPIT**

H-D V BOEHM (Messerschmitt-Boelkow-Blohm GmbH, Munich, West Germany) European Rotorcraft Forum, 10th, The Hague, Netherlands, Aug 28-31, 1984, Paper. 26 p. refs  
 (MBB-UD-420-84-OE)

The technical and physical aspects of helmet-mounted night vision goggles (NVG) with second and third-generation tubes are described. The night sky, the human eye, filters, blue/green lights and spectral dependence of image intensifiers are considered with respect to avoiding interference with NVG. Different solutions for NVG-compatible cockpit lighting, including the use of fiber optics for central illumination and cut-off filters in front of NVG, are also presented. The electroluminescent technique with bezels, strips, backlighting, in combination with dyed glass filters, was tested successfully, both for a modified and a new cockpit design. Also, the use of floodlights such as helmet-mounted spotlights, EL wristlight, and blue/green EL strips under the glare shield are discussed. Additional NVG tests with a color multifunction display (MFD) and a computer-generated imagery (CGI) simulator are analyzed. L T

**A85-16098\*#** Army Propulsion Lab., Cleveland, Ohio  
**COMPARISON OF ICING CLOUD INSTRUMENTS FOR 1982-1983 ICING SEASON FLIGHT PROGRAM**

R. F. IDE (U.S. Army, Propulsion Laboratory, Cleveland, OH) and G. P. RICHTER (NASA, Lewis Research Center, Cleveland, OH) American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 22nd, Reno, NV, Jan 9-12, 1984 24 p. Previously announced in STAR as N84-29870 refs  
 (AIAA PAPER 84-0020)

A number of modern and old style liquid water content (LWC) and droplet sizing instruments were mounted on a DeHavilland DHC-6 Twin Otter and operated in natural icing clouds in order to determine their comparative operating characteristics and their limitations over a broad range of conditions. The evaluation period occurred during the 1982-1983 icing season from January to March 1983. Time histories of all instrument outputs were plotted and analyzed to assess instrument repeatability and reliability. Scatter plots were also generated for comparison of instruments. The measured LWC from four instruments differed by as much as 20 percent. The measured droplet size from two instruments differed by an average of three microns. The overall effort demonstrated the need for additional data, and for some means of calibrating these instruments to known standards. Author

**A85-17805#**  
**DIGITAL FUEL QUANTITY INDICATING SYSTEM FOR AIRCRAFT**

R. L. NEWPORT, D. J. NELSON, and M. T. MANFRED (Honeywell, Inc., Minneapolis, MN) IN Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings New York, American Institute of Aeronautics and Astronautics, 1984, p 21-27  
 (AIAA PAPER 84-2602)

The digital fuel quantity indicating system is a state-of-the-art, high-accuracy system which has been developed for the new generation of commercial transport aircraft. Improved aircraft operating efficiency and simplified maintenance procedures are benefits provided by this system. The paper presents a description of the system and system output functions, the architecture of the system, and the operation of the system, including fuel measurement, fueling control and built-in test functions. Several new system features are discussed, such as linear uncharacterized fuel sensors and the densitometer, which contribute to the benefits provided by this system. Author

**A85-17808#**  
**AN OVERVIEW OF THE DIGITAL AVIONICS ASSESSMENT ACTIVITIES BEING CONDUCTED BY THE FEDERAL AVIATION ADMINISTRATION AT NASA-AMES RESEARCH CENTER**

W. LARSEN (FAA, Ames Development and Logistics Field Office, Moffett Field, CA), D. ELDREDGE, E. HITT (Battelle Columbus Laboratories, Columbus, OH), D. MULCARE, and W. NESS (Lockheed-Georgia Co., Marietta, GA) IN Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings New York, American Institute of Aeronautics and Astronautics, 1984, p 40-46  
 (AIAA PAPER 84-2605)

The introduction of software-based digital flight control and avionics technology in the current generation of aircraft has presented a problem for traditional certification techniques, especially due to the use of bus architectures for intersystems and intrasystems communications. The extreme flexibility afforded by these software-based digital information transfer systems presents significant problems in assuring that the software structure, including compilers, higher-order languages, and architectural design, is not adversely affected by changes in the firmware during the implementation or maintenance of these systems. Attention is presently given to research being conducted by the FAA at NASA-Ames Research Center in order to formulate a suitable certification process. O C

## 06 AIRCRAFT INSTRUMENTATION

### A85-17809#

#### RECENT ADVANCES IN AIRCRAFT ON-BOARD WEIGHT AND BALANCE SYSTEMS

J. P. OBRIEN (Sundstrand Data Control, Inc., Redmond, WA) IN: Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings. New York, American Institute of Aeronautics and Astronautics, 1984, p. 47-53 (AIAA PAPER 84-2606)

Temperature, shock, humidity, and vibration extreme impose rigorous requirements on aircraft weight and balance system weight-measuring transducers. Attention is presently given to hermetically sealed accelerometers used in weight and balance systems as inclinometers. This sensor design employs a quartz flexure-suspended proof mass as part of a servocontrol loop that generates an output current independently of output load, and allows full regime self-test. A temperature-sensing element is mounted on the accelerometer's magnet structure to allow temperature error modeling. This yields a set of fourth-order equations for temperature correction. The sensor unit is shown by both laboratory and aircraft tests to meet survivability, reliability, and maintainability design goals. O.C.

### A85-17811#

#### IMAGING SENSOR AUTOPROCESSOR

S. C. SAWTELLE and R. J. JENNEWINE (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) IN: Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings. New York, American Institute of Aeronautics and Astronautics, 1984, p. 60-64 (AIAA PAPER 84-2613)

The Imaging Sensor Autoprocessor (ISA) development effort has as its goal the augmentation of target recognition system operators' abilities and the optimization of their information handling capability. The target recognition algorithms under development for multisensor environments are intended for VHSIC implementation. The ISA must be capable of greater than 90-percent target detection and classification. Two systems are under competitive development, and will be ready for testing by 1986. O.C.

### A85-17828#

#### GENERAL AVIATION DATA BUS UPDATE

D. L. STANISLAW (Cessna Aircraft Co., Wichita, KS) IN: Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings. New York, American Institute of Aeronautics and Astronautics, 1984, p. 180-183 (AIAA PAPER 84-2637)

Efforts to simplify wiring interconnections between the black boxes of aircraft electronics systems are reviewed. The cabling is routed between the electronics and between the avionics and control actuators. Cabling is particularly heavy behind the instrument panel. Computer graphics and modeling are employed to check all continuity and short circuit locations in final design phases. ARINC 429, the standard data bus for transport aircraft in the free world, has not provided cabling weight savings. Attempts at cabling reductions being made include bi-directional cables and optic fiber connections. Examinations are also being performed on distributed control systems, serial connections, parallel wiring and a TDMA system. Criteria for the new wiring schemes comprise handling all flight system, adapting to hazardous weather conditions, amenability to expansion, and security from lightning damage. Additionally, the systems must be able to use both wire and fiber optics and be bi-directional in operation. M.S.K.

### A85-17831#

#### CURRENT AND FUTURE GENERAL AVIATION EFIS DEVELOPMENTS

J. A. OGANN (Rockwell International Corp., Collins General Aviation Div., Cedar Rapids, IA) IN: Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings. New York, American Institute of Aeronautics and Astronautics, 1984, p. 193-198. (AIAA PAPER 84-2642)

Electronic flight instrumentation systems (EFIS) under development or in use on general aviation aircraft are surveyed. EFIS became possible when high reliability CRT displays were produced for the cockpit. The key factor was the manufacture of vibration-proof shadow mask tubes, certifiable high voltage systems, high speed processors and A/D converters and high level language implementation. Display formats have been defined for airspeed, airspeed trend, Mach number, take-off acceleration, flight mode, ground speed, and radio altitude. Full altimetry is still under study. Efforts have been expended to produce displays that mimic mechanical gages to interface with pilot familiarities. Color standards are being established for various information categories, and decisions are being made of acceptable multifunction displays. It is noted that cockpit display technology is still in its infancy and that major changes are to be expected in all display components and functions. M.S.K.

### A85-17844#

#### SOFTWARE CONTROLLED DISPLAY/PUSHBUTTON

D. A. NICHOLSON (Honeywell, Inc., Micro Switch Div., Freeport, IL) and R. J. SPIGER (Boeing Aerospace Co., Seattle, WA) IN: Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings. New York, American Institute of Aeronautics and Astronautics, 1984, p. 285-290 (AIAA PAPER 84-2657)

The designs for two devices which improve the operator/systems interface in modern avionics are described, together with possible applications of the devices in a keyboard. The product is a programmable display pushbutton interfacing with an LED 560 pixel dot-matrix display. The Hall effect switch requires 3 lb pressure to activate. Panels can be configured with any desired number of switches, which will interface with the host computer through RS422 or RS232 connections. The microprocessor-based control unit allows for ASCII conversion, bit/pattern mapping, brightness control, display blinking, self-test, and display refresh. The switches can call up menus or alter the function of other switches. Update after switching takes 200 msec. M.S.K.

A85-17845\*# Army Electronics Research and Development Command, Fort Monmouth, N. J.

#### RECENT ADVANCES IN ELECTROLUMINESCENT DISPLAYS APPLICABLE TO FUTURE CREW-STATION INTERFACES

M. R. MILLER, E. SCHLAM (U.S. Army, Electronics Research and Development Command, Fort Monmouth, NJ), J. B. ROBERTSON, and J. J. HATFIELD (NASA, Langley Research Center, Hampton, VA) IN: Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings. New York, American Institute of Aeronautics and Astronautics, 1984, p. 291-295 (AIAA PAPER 84-2663)

The operative principles and progress to date on producing thin-film electroluminescent displays (TFEL) are discussed. TFEL displays consist of conductive, insulating and phosphor film layers deposited on a glass substrate. Applying a 200 V potential between the rows and columns in a multiplexed mode causes light to be emitted. Varying the voltage varies the grey level. The panels provide adequate contrast in full sunlight, and have demanded only 4-6 W for 15 sq. in. displays. Alphanumeric, graphics, and video images have been generated with a 51 line by 80 character display. The upper limit on the panel size has not yet been defined. Efforts are under way to produce multicolor displays using red and blue phosphors. Trial units are being studied for avionics displays for, e.g., navigation, multipurpose displays, and attitude/direction indicators. M.S.K.



**A85-17846#****ALPHA-SI ADDRESSED LIQUID CRYSTAL AIRCRAFT DISPLAY**

D. E. CASTLEBERRY, J. E. BIGELOW, H. G. PARKS, W. W. PIPER, and G. E. POSSIN (General Electric Co., Schenectady, NY) IN Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings New York, American Institute of Aeronautics and Astronautics, 1984, p. 296-300 refs (AIAA PAPER 84-2659)

The theory, performance requirements, manufacturing techniques, and applications of thin-film transistor (TFT) LCDs are outlined. Each pixel possesses a TFT switch which controls the state of the LCD. The display is scanned one line at a time with voltages sufficient to charge the LC capacitors. After the screen is fully scanned the voltage polarity is inverted and a refresh voltage is initiated. The cycle takes no more than 10 msec. The on/off current ratio is at least 5000, which has been sustained at temperatures up to 90 C when phenyl cyclohexane was used as the LC. The most favorable TFTs have been plasma vapor-deposited alpha-Si films upon which the less-than 6 microns thick LC material is deposited. Black/white avionics displays with contrasts of better than 50:1 have been produced. Incorporating filters between the glass cover and the common electrode permits color displays. Finally, a method of using the TFT-LCD as the source for a HUD is outlined. M S K

**A85-17865\*#** National Aeronautics and Space Administration, Langley Research Center, Hampton, Va.

**AN ADVANCED MEDIA INTERFACE FOR CONTROL OF MODERN TRANSPORT AIRCRAFT NAVIGATIONAL SYSTEMS**

D. R. JONES, R. V. PARRISH, L. H. PERSON, JR. (NASA, Langley Research Center, Hampton, VA), and J. L. OLD (Research Triangle Institute, Research Triangle Park, NC) IN Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings New York, American Institute of Aeronautics and Astronautics, 1984, p. 421-428 refs (AIAA PAPER 84-2686)

With the advent of digital avionics, the workload of the pilot in a modern transport aircraft is increasing significantly. This situation makes it necessary to reduce pilot workload with the aid of new advanced technologies. As part of an effort to improve information management systems, NASA has, therefore, studied an advanced concept for managing the navigational tasks of a modern transport aircraft. This concept is mainly concerned with the simplification of the pilot interface. The advanced navigational system provides a simple method for a pilot to enter new waypoints to change his flight plan because of heavy traffic, adverse weather conditions, or other reasons. The navigational system was implemented and evaluated in a flight simulator representative of a modern transport aircraft. Attention is given to the simulator, flight simulation, multimode devices, and the navigational system. G R.

**A85-17866\*#** National Aeronautics and Space Administration, Langley Research Center, Hampton, Va.

**A SIMULATOR APPLICATION OF A 'HANDS-ON THROTTLE AND STICK' CONCEPT TO A TRANSPORT PILOT/AUTOPILOT INTERFACE**

A. M. BUSQUETS, R. V. PARRISH, and T. W. HOGGE (NASA, Langley Research Center, Hampton, VA) IN Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings New York, American Institute of Aeronautics and Astronautics, 1984, p. 429-434 refs (AIAA PAPER 84-2687)

This paper presents the initial experiences garnered in applying a multifunction control strategy, based on the U.S. Air Force's 'Hands-On Throttle-and-Stick' concept for fighter aircraft to a transport aircraft simulator. The multifunction control strategy involves the activation of various flight system/subsystem operations (such as guidance and control, communication, and navigation functions) by use of menu displays and throttle and stick switches. The initial application of this multifunction control (MFC) concept was developed around a pilot/autopilot interface, contrasting a conventional, dedicated autopilot interface to an MFC

implementation. The simulator characteristics and autopilot functions, as well as the conventional interface and MFC hardware/software, which were utilized in the application, are described herein. Initial pilot reaction and suggested improvements to this particular implementation are discussed. The paper terminates with a glance at plans for improvements and future applications based on the outcome of this initial study. Author

**A85-17867#****MICRO-BASED CONTROL AND DISPLAY RESEARCH**

D. A. SOBOTA, G. D. LIZZA, and J. M. REISING (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) IN Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings New York, American Institute of Aeronautics and Astronautics, 1984, p. 435-440 (AIAA PAPER 84-2688)

Simulators have provided an effective approach for the investigation of new technologies related to advanced controls and displays for cockpits. Advances in simulator capacities have been accompanied by corresponding advances with respect to the employed mainframe computers. A disturbing aspect of this development is related to the economics of simulation. In connection with the arising costs, it is, therefore, important to seriously consider the level of simulation needed for a particular research area. It is pointed out that for basic concept evaluation, the researcher would be well advised to consider the feasibility of a fixed-based, dynamics cockpit. A description is presented of a dynamic cockpit which provides the capability to conduct control and display research over a broad range of experimentation. This cockpit is designed around four 8086/8087 microcomputers. G R.

**A85-17868#****CERTIFICATION OF A HOLOGRAPHIC HEAD-UP DISPLAY SYSTEM FOR LOW VISIBILITY LANDINGS**

J. P. DESMOND and D. W. FORD (Flight Dynamics, Inc., Hillsboro, OR) IN Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings New York, American Institute of Aeronautics and Astronautics, 1984, p. 441-446 refs (AIAA PAPER 84-2689)

The purpose of this paper is to summarize the approach taken to achieve certification for operations in CAT III weather minimums (down to 700 ft runway visual range) through guidance information presented on a single Head-Up Display. The paper discusses the original strategy designed to meet FAA requirements, the effect of these requirements on the system design, and additional requirements imposed by the man-in-the-loop and the target aircraft. System architecture and aircraft sensor requirements are outlined. The simulation and flight test program are described, and some test results are provided. Author

**A85-17874#****MAINTENANCE ASSIST FUNCTIONS EMBEDDED WITHIN THE 737-300 FLIGHT MANAGEMENT SYSTEM**

G. F. ELLIS (Boeing Co., Seattle, WA) and H. E. HOFFERBER (Sperry Corp., Sperry Flight Systems, Phoenix, AZ) IN Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings New York, American Institute of Aeronautics and Astronautics, 1984, p. 485-491. (AIAA PAPER 84-2706)

The paper presents the design, and design philosophy, of a 'federated' Maintenance system employed on the Flight Management System (FMS) on the new Boeing 737-300 commercial jet transport. Covered are the design guidelines followed in developing the system, and how the airline customers are envisioned to utilize the system in practice. The design of the Maintenance Assist Function is then discussed for the more complex of the 'federated' built-in test (BITE) systems, namely the Digital Flight Control System (DFCS). Within the discussion, the design for Ground Maintenance BITE, in-flight Continuous Monitoring, and the Maintenance Monitoring fault storage and readout is detailed. Finally, the paper addresses the experience gained by the development team, with the introduction of

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sophisticated BITE systems, in the new airplanes that are equipped with digital avionics. In general, the paper provides a baseline 'federated' BITE concept as applied to the major onboard computing systems of the FMS. However, a conceptual foundation is provided which could be expanded to cover more onboard avionics systems as future commercial airplane types are developed. Author

### A85-17875#

#### INTEGRATED ON-BOARD MONITORING AND TEST CONCEPTS

P. C. JENKINS and C. J. ONG (Rockwell International Corp., Collins Government Avionics Div., Cedar Rapids, IA) IN: Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings. New York, American Institute of Aeronautics and Astronautics, 1984, p. 492-497 refs (AIAA PAPER 84-2709)

The problem of developing effective on-board test and monitoring is examined using a systems-level approach. Emphasis is placed on the development of a set of required support modules based on a layered functional architecture. The foundation of the system architecture is provided by the LRU (line replaceable units), subsystem, and acquisition layers; other layers include translation, operation, classification, association, and presentation. A cost-effective, open-ended design philosophy is formulated in terms of current and near-term capability. V.L.

### A85-17878#

#### CRASH-SURVIVABLE FLIGHT DATA RECORDER

G. E. DAVIS (General Dynamics Corp., Fort Worth, TX) IN: Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings. New York, American Institute of Aeronautics and Astronautics, 1984, p. 508-512 (AIAA PAPER 84-2705)

The Crash Survivable Flight Data Recorder is a multipurpose, solid state, data recording system designed to meet aircraft requirements for fleet management data collecting and incident recording. The physical design of the hardware has been standardized to meet the recording needs of current and future aircraft by adapting to a specific airframe through interface and software program changes. The CSFDR comprises two LRU's: Signal Acquisition Unit (SAU) and Crash Survivable Memory Unit (CSMU). The SAU uses MIL-STD-1750A processor technology, programmed in J73, to receive, process, compress and store fleet management data into its four-megabit Auxiliary Memory Unit. The CSMU provides for 28,000-word storage of incident data. Details on F-16 implementation and data collection requirements are presented with features identified that enhance the adaptability of the system. Author

### A85-17901#

#### ACCURACIES OF DIGITAL ENGINE MONITORING PROVEN BY PERFORMANCE

J. BALAZIC (Boeing Commercial Airplane Co., Seattle, WA) and J. BLUISH (Bendix Corp., Energy Controls Div., South Bend, IN) IN: Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings. New York, American Institute of Aeronautics and Astronautics, 1984, p. 653-660 (AIAA PAPER 84-2753)

Functional and performance features of the microprocessor-based propulsion multiplexer (PMUX) aircraft engine monitoring unit are described. PMUX converts sensor data into a storable digital format and comprises an input interface, pressure sensors, a CPU, a solid-state memory, output interface, power converter and a maintenance memory. It is compatible with ARINC 429 input and can store continuous engine data, i.e., temperature, rpm, mass flow, and engine bleed air, for later analyses. Data are sampled every 20 msec. Certification flight tests of the 747-300 with the PMUX interfaced with the JT9D-7R4G2 engine provided real-time data which validated the engine performance within specifications. PMUX is now used in-service on transport aircraft for engine condition monitoring. M.S.K.

### A85-17902#

#### THE F110 ENGINE MONITORING SYSTEM

M. J. ASHBY and R. J. E. DYSON (General Electric Co., Cincinnati, OH) IN: Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings. New York, American Institute of Aeronautics and Astronautics, 1984, p. 661-666 (AIAA PAPER 84-2754)

The engine monitoring system (EMS) for the F110 engine is described, along with performance features. The EMS was designed to detect operation outside the design envelope, return the engine to normal limits, acquire and store data on operational parameters, report engine flight readiness, and interface with ground-based analysis software. The full-scale unit consists of an engine mounted processor, airframe mounted computer, and a data display and transfer unit. The system monitors 22 engine parameters and records seven other aircraft parameters reported through a bus. The data are used for diagnostics, parts life tracking, trend identification, and pilot initiated alerts. Flight tests of the full system are projected for late 1985 or 1986. M.S.K.

N85-14814\*# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

#### SOME THOUGHTS ON THE IMPLEMENTATION OF PILOT NIGHT VISION DEVICES FOR HELICOPTERS

G. E. TUCKER IN: Technical Workshop Advanced Helicopter Cockpit Design Concepts, p. 95-104, Dec. 1984. Avail: NTIS HC A15/MF A01 CSCL 01D

Night vision enhancement devices greatly expand the range and quality of services by extending night operational capabilities. Evolving military tactical concepts for helicopters survivability and battlefield effectiveness necessitate nap-of-the-earth (NOE) flying under both day and night conditions. From a pilot workload standpoint, flying a helicopter NOE in day VFR conditions with minimum clearance between rotors and obstacles is quite demanding. Doing the same job at night is several times more difficult. There are two general categories of night vision devices in operation in helicopter aviation: the Night Vision Goggles (NVG) and forward looking infrared (FLIR) system. The capabilities and limitations of those two devices are discussed. B.G.

N85-14815\*# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

#### HH-65A DOLPHIN DIGITAL INTEGRATED AVIONICS

R. B. HUNTOON IN: NASA, Ames Research Center Technical Workshop Advanced Helicopter Cockpit Design Concepts, p. 107-120, Dec. 1984. Avail: NTIS HC A15/MF A01 CSCL 01D

Communication, navigation, flight control, and search sensor management are avionics functions which constitute every Search and Rescue (SAR) operation. Routine cockpit duties monopolize crew attention during SAR operations and thus impair crew effectiveness. The United States Coast Guard challenged industry to build an avionics system that automates routine tasks and frees the crew to focus on the mission tasks. The HH-64A SAR avionics systems of communication, navigation, search sensors, and flight control have existed independently. On the SRR helicopter, the flight management system (FMS) was introduced. It coordinates or integrates these functions. The pilot interacts with the FMS rather than the individual subsystems, using simple, straightforward procedures to address distinct mission tasks and the flight management system, in turn, orchestrates integrated system response. B.G.

N85-14818\*# Naval Air Development Center, Warminster, Pa.

#### AVIONICS/CREW STATION INTEGRATION

W. G. MULLEY IN: NASA, Ames Research Center Technical Workshop Advanced Helicopter Cockpit Design Concepts, p. 165-172, Dec. 1984. Avail: NTIS HC A15/MF A01 CSCL 01D

The U.S. Navy has been encouraging advanced development concepts aimed at increasing the aircraft instrumentation performance for multi-platform applications of 1990's weapons systems. The three areas covered by the Navy's research and

development effort are System Integration, Technology, and Human Factors. The System Integration objectives are to produce a system architecture easily adaptable to many platforms. Technology objectives are to determine the state of the art for displays, electronics, and controls. The Human Factors objectives are to determine the proper human-machine interfaces so that the ultimate crew station will be capable of providing the pilot with the proper display and controls performance to satisfy the diverse requirements of a fighter, attack, ASW, fixed-wing, rotary-wing, and V/STOL platforms in both a one-man crew or two-man crew matrix. All data/control interface among units of this crew station and other platform subsystems will be via digital data buses and video multiplex buses. No individual discrete signal, data, or control lines will be needed. This paper discusses the six interfaces necessary to ensure the optimum development of this crew station, the predicted platform mission improvements, and the requisite life-cycle cost considerations. This concept will serve as a basis for planning the integration of the necessary hardware and software features in current and future weapons systems.

B.W

#### **N85-14829\*# Federal Aviation Administration, Fort Worth, Tex CERTIFICATION OF ADVANCED SYSTEMS**

J D SWIHART, JR. /in NASA Ames Research Center Technical Workshop Advanced Helicopter Cockpit Design Concepts p 325-349 Dec 1984 refs  
Avail NTIS HC A15/MF A01 CSCL 01D

Advanced cockpit systems in helicopters are evaluated in terms of safety certification areas of concern include (1) power supply system, failure analysis, (2) software control; (3) lightning substantiation, and (4) adequacy of certification regulations

B W

## 07

## **AIRCRAFT PROPULSION AND POWER**

Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors, and on-board auxiliary power plants for aircraft.

**A85-16097\*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio**

#### **SENSOR FAILURE DETECTION FOR JET ENGINES USING ANALYTICAL REDUNDANCY**

W C MERRILL (NASA, Lewis Research Center, Cleveland, OH) AIAA, SAE, and ASME, Joint Propulsion Conference, 20th, Cincinnati, OH, June 11-13, 1984 23 p Previously announced in STAR as N84-24585 refs  
(AIAA PAPER 84-1452)

Analytical redundant sensor failure detection, isolation and accommodation techniques for gas turbine engines are surveyed. Both the theoretical technology base and demonstrated concepts are discussed. Also included is a discussion of current technology needs and ongoing Government sponsored programs to meet those needs.

Author

**A85-16231#**

#### **ANALYTICAL METHOD FOR DETERMINING THE VOLUMETRIC EFFICIENCY AND POWER LOSSES RESULTING FROM RESISTANCE IN THE INLET AND EXHAUST SYSTEMS OF A PISTON ENGINE [ANALITYCZNA METODA OKRESLANIA WSPOLCZYNNIKA NAPELNIENIA I MOCY TRACONEJ WSKUTEK OPOROW PRZEPLYWU UKLADU DOLOTOWEGO I WYLOTOWEGO SILNIKA TLOKOWEGO]**

M ORKISZ, R PROCIAK, and S SZCZECINSKI Technika Lotnicza i Astronautyczna (ISSN 0040-1145), vol 39, July 1984, p 12-14 In Polish refs

**A85-16237\*# Texas A&M Univ, College Station**

#### **PRACTICAL FLIGHT TEST METHOD FOR DETERMINING RECIPROCATING ENGINE COOLING REQUIREMENTS**

D T WARD and S J MILEY (Texas A & M University, College Station, TX) Journal of Aircraft (ISSN 0021-8669), vol 21, Dec 1984, p. 936-942. Research supported by the Texas A & M University refs  
(Contract NSG-1083)

It is pointed out that efficient and effective cooling of air-cooled reciprocating aircraft engines is a continuing problem for the general aviation industry. Miley et al. (1981) have reported results of a study regarding the controlling variables for cooling and installation aerodynamics. The present investigation is concerned with experimental methods which were developed to determine cooling requirements of an instrumented prototype or production aircraft, taking into account a flight test procedure which has been refined and further verified with additional testing. It is shown that this test procedure represents a straightforward means of determining cooling requirements with minimal instrumentation. Attention is given to some background information, the development history of the NACA cooling correlation method, and the proposed modification of the NACA cooling correlation.

G R

**A85-16270**

#### **UDF - GE DARES TO DIFFER**

G WARWICK Flight International (ISSN 0015-3710), vol. 126, Nov 10, 1984, p 1239, 1242

The development of a conceptually new unducted fan (UDF) as a replacement for the turbofan is discussed. Though being principally similar to the propfan, the UDF has a helical Mach 1 or higher, higher forward speeds, higher load carried by each blade, and, in comparison to the existing turbofans, a 25 percent better specific fuel consumption and a cruise s f c of 0.40 against the existing 0.56. A full-scale demonstrator engine is being developed, which will begin ground runs in summer 1985. The UDF is driven directly, which eliminates the power limitations of the gearbox while the noise level increase due to the contrarotating blades is expected to be eliminated by synchrophasing. A 10 percent weight reduction of the propulsion system will be achieved. NASA figures also show a 90 percent propulsive efficiency for a 65 s h p /D square, eight-blade, contrarotating UDF, as compared to 86 percent efficiency for a 35 s h p /D-squared eight-blade single rotation propfan.

L T

**A85-16271**

#### **PW2037 STARTS WORK**

J MOXON Flight International (ISSN 0015-3710), vol 126, Nov. 10, 1984, p 1246, 1247, 1250-1252, 1256.

The new PW2037 turbofan engine with 39,000 lbs thrust, designed with an emphasis on fuel efficiency and the latest state-of-the-art, is analyzed. The use of new materials, such as the nickel-based steel alloy PW1100, yielded higher rotational speeds and better efficiency. The engine utilizes an active clearance control system (ACC), which reduces the blade tip clearance during cruise. Other performance retention features include: extra-stiff engine cases to maintain engine and rotor concentricity, a combustor with a 'double pass' burner liner, internal thermal barrier coatings to reduce maximum metal temperatures by 56 C, and modular design for simplified maintenance. The engine uses the full authority digital engine control (Fadec), which improves the pilot's interface with the engine and provides smoother power management. The engine is considered for both commercial and military use. An exploded-view drawing of the engine is provided, together with technical specifications.

L T

**A85-16272**

#### **THE SILENCERS**

J. MOXON Flight International (ISSN 0015-3710), vol. 126, Nov 10, 1984, p 1262, 1263

Various modifications of the JT3D-powered 707's and DC-8's compliance with the FAA's Stage 2 noise regulations are considered, such as a complete engine retrofit which includes a range of airframe and avionics options possibly resulting in a

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virtually new aircraft. Over 70 such retrofits were completed, aside from noise reduction, improvement in fuel efficiency was noted by the operators. Three conversions of a less profound nature are also described. The Noise Reduction Nacelle (NRN), offering a 4 percent reduction in fuel burn and a 2 percent thrust benefit, is based on an extended bypass duct and acoustic linings. Another proposal consists of the acoustically treated nose cowl inner barrel and fan duct inner wall, and modified extended thrust reverser translating sleeve. The third proposal comprises a new nacelle with a 12 in. larger inlet cowl and a 12 in. cylindrical extension bolted to the nose dome flange. The approximate cost of each conversion is given. L.T.

**A85-16576**

### THE EFFECT OF VIBRATION ON FILM COOLING OVER A GAS TURBINE BLADE

S. KIKKAWA and M. NONOGAKI (Doshisha University, Kyoto, Japan) Heat Transfer - Japanese Research (ISSN 0096-0802), vol. 13, Apr.-June 1984, p. 1-14. Translation refs

The effect of vibration on the film cooling of a gas turbine blade was experimentally studied. The coolant containing CO<sub>2</sub> gas was two-dimensionally injected from a slot located near the stagnation point of the blade. For the measurement of film cooling effectiveness, the analogy between heat transfer and mass transfer was utilized. The film cooling effectiveness on the pressure side of the blade decreases with increasing frequency and amplitude except in the vicinity of injection slot. On the suction side, the film cooling effectiveness upstream of the separation point increases with increasing frequency and amplitude but the film cooling effectiveness downstream from the separation point is not affected by vibration. The tendencies mentioned above are valid when the ratio of the velocity of the blade by vibration to the stream velocity along the blade is relatively small. When the velocity ratio is large, the opposite tendencies were observed. Author

**A85-16916**

### THE BUCKLING OF A STIFFENED CYLINDRICAL SHELL HEATED BY AN INTERNAL GAS FLOW WITH VARYING THERMODYNAMIC PARAMETERS [VYPUCHIVANIE I POTERIA USTOICHIVOSTI PODKREPLENNOi TSILINDRICHESKOI OBOLOCHKI, NAGREVAEMOI VNUITRENNIM POTOKOM GAZA PEREMENNYKH TERMODINAMICHESKIKH PARAMETROV]

A. G. ZGUROVSKIi Problemy Prochnosti (ISSN 0556-171X), Nov 1984, p. 108-112. In Russian. refs

The buckling of cyclically heated shells is investigated using the exhaust pipes of the turboprop engines of the An-22 aircraft as an example. It is shown analytically and experimentally that in the case of the combined effect of two loading factors, i.e., 'cold diaphragms' and nonuniform heating along the cross-section perimeter, buckling occurs at a significantly lower temperature than in the case where these factors act independently. V.L.

**A85-17041#**

### INVISCID STEADY FLOW PAST TURBOFAN MIXER NOZZLES

W. C. CHIN (Applied AeroNalysis, Houston, TX) ASME, Transactions, Journal of Applied Mechanics (ISSN 0021-8936), vol. 51, Dec 1984, p. 937-939

Analytical models are defined for hot and cold core flow wake interaction boundary conditions as an aid to understanding jet mixing. The models cover irrotational flows characterized by unequal inner and outer reference pressures, speeds and densities. The potentials are calculated upstream, at the shroud, and at the trailing edge slipstream (where vorticity is concentrated). Continuity is assumed for the potential derivatives and over jumps. Techniques are identified for defining simplified, accurate expressions for branch cuts in mixer and powered engine flows. The mean radius is found to be the most significant parameter for producing flows with high azimuthal slip, while the flow velocity and radius determine mixer effectiveness. M S K

**A85-17077**

### SOLVING THE INVERSE PROBLEM OF DETERMINING THE THERMODYNAMIC PROPERTIES OF THE WORKING MEDIUM OF GAS TURBINE ENGINES [RESHENIE OBRATNOI ZADACHI OPREDELENIIA TERMODINAMICHESKIKH SVOISTV RABOCHEGO TELA GAZOTURBINNYKH DVIGATELEI]

A. N. PROKOFEV Aviatsonnaia Tekhnika (ISSN 0579-2975), no. 2, 1984, p. 107, 108. In Russian

Reference is made to the method proposed by Tunakov (1979) which provides an efficient way of calculating the enthalpy and entropy functions of the working medium of gas turbine engines when temperature is a given. However, a much greater computational effort is required for solving the inverse problem where temperature is to be determined from the thermodynamic functions. An efficient noniterative algorithm for solving the inverse problem is proposed and verified experimentally. The algorithm is based on a good initial approximation of temperature and solves the inverse problem a factor of 5-10 faster than Tunakov's method. V.L.

**A85-17229#**

### DEVELOPMENT OF THE PW100 TURBOPROP ENGINES

D. L. COOK (Pratt and Whitney Canada, Longueuil, Quebec, Canada) (Canadian Aeronautics and Space Institute, Annual General Meeting, 31st, Ottawa, Canada, May 28, 1984) Canadian Aeronautics and Space Journal (ISSN 0008-2821), vol. 30, Sept. 1984, p. 230-239

Design and hardware choices in the development of the PW100 line of turboprop engines are summarized. The main components are the turbomachinery (TM) and reduction gearbox. The TM has three concentric main shafts, two centrifugal compressors in series, and counterrotating HP and LP spools. The engine has a unitary lubrication system. The HP rotor speed is governed by the same electronic system that sets a torque target for the pilot to hit in a given flight phase. The concept-to-production model process took 9 yr, including a one year slip to accommodate the P115, P120, and P124 variants, each with a successively higher horsepower ratings. Design modifications made to avoid resonance conditions between parts, armor the diffuser pipes, and to make correct choices of seals for various ducts and joints are discussed. M.S.K.

**A85-17895#**

### A MINIMUM INTERRUPTION AC ELECTRIC POWER GENERATING SYSTEM FOR AVIONICS

B. MEHL and G. PIERCE (Sundstrand Corp., Rockford, IL) IN Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings. New York, American Institute of Aeronautics and Astronautics, 1984, p. 619-623 (AIAA PAPER 84-2742)

Momentary electrical power interruptions caused by bus transfers during startup occur on aircraft load buses supplying 115 VAC 400 Hz power. These brief interruptions can upset avionics subsystems requiring manual reset. This paper discusses the causes and effects of these phenomena in more detail, especially interruptions which occur during normal operation such as when load buses are transferred between sources. Techniques to eliminate these normal interruptions exist and can easily be applied in modern controls for electrical generating systems. Author

**A85-18721**

### AERONAUTICAL GAS TURBINES - I [LES TURBINES A GAZ AERONAUTIQUES - I]

J. MORISSET Air et Cosmos (ISSN 0044-6971), vol. 22, Dec 8, 1984, p. 17-19, 22. In French

The production and developmental efforts by two French concerns, SNECMA and Turbomeca, in supplying gas turbines for aircraft propulsion systems are surveyed. SNECMA is undergoing a major expansion to meet the demands of both civil and military markets. Already manufacturing the Olympus engines for the Concorde and exporting 65 percent of its products, the company devotes 25 percent of its operational expenses to R and D. The company also continuously orders parts and work from 3000 other

companies. The main business is military, including the M53 5 18,000 lb thrust engine for the Mirage 2000 and the M53-P2 19,400 lb thrust engine for the 2000 export version. The M88 engine, delivering at least the same power level, is under development for use in the 1990s and will weigh significantly less. The CFM 56-2 is being sold as a replacement engine for the U.S.A.F. KC-135 R. Turbomeca supplies four families of turbojets. The newest products are the TM 319, TM 333, the RTM.322, and the MTM 385, the last being targeted for helicopters in 1986. Flight trials are under way for the RTM 322, which will be installed in military helicopters. M S K.

#### A85-18722

#### AERONAUTICAL GAS TURBINES. II [LES TURBINES A GAZ AERONAUTIQUES. II]

J. MORISSET. *Air et Cosmos* (ISSN 0044-6971), vol 22, Dec 15, 1984, p 19-21, 52. In French.

Gas-turbine aircraft engines under development or in production at RR and GE are reviewed. At RR, production engines include the RB 211-524 (performing with only 1-percent degradation over 1600 cycles in B-747s) and the RB 211-535C (0.5-percent deterioration over 1200 cycles in B-757s). Under development are the RTM322, the Mk552 Advanced Dart, and the Tyne for the 2000-5000-hp range, the 6-tonne-thrust Tay for the Fokker 100 and Gulfstream IV; the 10.4-11.3-tonne V2500 for 150-seat aircraft, and improved versions of the RB211-535C, the RB199, and the Pegasus directed-thrust engine. At GE, military-engine production centers on the 11.8-13.15-tonne F-110 (for F-16 and F-14D aircraft), the 7.25-9-tonne F404 (for F/A-18, F-18, F-20, X-29A, the Swedish JAS-39, and the Dassault ACX), the T-700 (for helicopters), and the TF-39 (for the C-5B). In the commercial-aviation field, the focus is on the upcoming tests of the 25,000-hp unducted-fan engine, which is expected to offer fuel-consumption savings of 40-60 percent relative to standard turbofans. T K.

#### A85-18792\*# General Electric Co., Cincinnati, Ohio

#### CONSIDERATIONS FOR DAMAGE ANALYSIS OF GAS TURBINE HOT SECTION COMPONENTS

T. S. COOK and J. H. LAFLEN (General Electric Co., Cincinnati, OH). American Society of Mechanical Engineers, Pressure Vessels and Piping Conference and Exhibition, San Antonio, TX, June 17-21, 1984. 7 p. refs.

(Contract NAS3-22534)

(ASME PAPER 84-PVP-77)

The hot flowpath of a gas turbine engine contains static and rotating components operating in a very hostile environment. Since the reliable operation of these components is critical to the safe and efficient performance of the engine, structural life analysis of these members is carried out with great care. However, the complex nature of the strain-temperature-time cycle affecting the engine makes a general analysis procedure difficult and usually leads to separating the damage into regimes where one damage mode dominates. In particular, cycle dependent, time dependent, and thermomechanical fatigue regimes have been identified and some general considerations of each region are discussed. This discussion includes both the damage models themselves and the application of the models. Specific examples of several models are given and important factors affecting each are presented.

Author

#### N85-13796 Cincinnati Univ., Ohio

#### SURGE TRANSIENT SIMULATION IN TURBO-JET ENGINE Ph.D. Thesis

Y. SUGIYAMA. 1984. 264 p.

Avail. Univ. Microfilms Order No. DA8420917

Surge transient flow phenomena and unsteady compressor operating point excursion during surge in a turbojet engine, is analyzed using a dynamic simulation model. A one-dimensional model which is capable of simulating very large surge disturbance propagations in the direction of the engine axis from the air intake to the exhaust nozzle was developed. Disturbances to which the engine response leading to surge is simulated, are unsteady planar inlet total pressure and temperature disturbance, fuel pulse at the

combustor and exit nozzle area throttlings. The unknown stalled characteristics of the compressor stages were predicted through a parametric study based on the agreement of the overall computed results, such as surge hammer over-pressures and reduced burner pressures, with the available experimental data. It was found that the stall method, i.e. the surge-causing disturbance, significantly affects the compressor operating point excursion and thus the surge flow transient phenomena. The mass flow rate through the compressor reduced to a very low (nearly zero or negative) value in roughly 10 milliseconds. Dissert. Abstr.

#### N85-13797 California Inst. of Tech., Pasadena.

#### PRESSURE OSCILLATIONS IN LIQUID-FUELED RAMJET ENGINES Ph.D. Thesis

V. YANG. 1984. 188 p.

Avail. Univ. Microfilms Order No. DA8420843

Pressure oscillations in liquid fueled ramjet engines were studied. Linear unsteady motions in coaxial dump configurations were examined. The flowfield in the dump combustor is approximated by division into three parts: a flow of reactants, a region containing combustion products, and a recirculation zone, separated by two infinitesimally thin sheets, the flame and the vortex sheets. The oscillatory field in the inlet is coupled in the field in the combustor at the dump plane to determine the complex frequencies characterizing the linear stability of the engine. The nonlinear behavior of the shock wave in the inlet diffuse was investigated. The response of a shock wave to various disturbances, including finite and large amplitude oscillations was studied. The results serve as a basis for stability characteristics of the inlet flow analysis. The pressure oscillations in side dump ramjet engines were discussed. The flowfields were constructed in two regions: the inlet section, including a region of fuel injection, and a dump combustor. The oscillatory characteristics engine are determined by its response to a disturbance imposed on the mean flow. Dissert. Abstr.

#### N85-14962# Joint Publications Research Service, Arlington, Va. DEVICE FOR MEASURING RELATIVE AXIAL EXPANSION OF TURBINE ROTOR EMPLOYING SPACE-VECTOR TRACKING METHOD Abstract Only

V. M. KAPINOS, V. A. KUSENKO, L. A. ZARUBIN, Y. I. ZIMICHEV, V. G. ZYUZKIN, F. Y. LYAKHOV, V. Z. PALEY, M. D. TKACHENKO, V. D. FESENKO, and Y. L. KHRESTOVOY. *In its USSR Rept.: Eng. and Equipment* (JPRS-UEQ-84-007) p 27. 14 Nov 1984. Transl. into ENGLISH from *Elektr. Stantsii* (Moscow), no 3, Mar 1984. p 27-29.

Avail. NTIS HC A04/MF A01

A device for measuring the relative axial expansion of turbine rotors is described that overcomes the deficiencies of the devices now in use and has good metrological properties. The parameters of the device are analyzed through laboratory tests that indicate its suitability for new as well as existing turbines. Author

#### N85-14964# Joint Publications Research Service, Arlington, Va. PREDICTING CHANGES IN RELIABILITY CHARACTERISTICS OF GAS TURBINE ENGINES DURING OPERATION Abstract Only

V. P. CHEPRASOV and Y. T. VULIKH. *In its USSR Rept.: Eng. and Equipment* (JPRS-UEQ-84-007) p 28. 14 Nov 1984. Transl. into ENGLISH from *Izv. Vyssh. Ucheb. Zaved. Aviat. Tekhn. (Kazan)*, no 4, Oct-Dec 1983. p 68-72. Previously announced in IAA as A84-30420.

Avail. NTIS HC A04/MF A01

An approach is outlined to solving the problem of diagnosing the condition of mass produced gas turbine engines and predicting the changes that occur from use. It is pointed out that calculations at present rely on two assumptions. The first is that the law governing the distribution of times during which the engines operate without failure is exponential. The second is that all the engines are of uniform reliability. It is shown that models incorporating these assumptions can be improved by modifying the first assumption. The approach outlined involves an analysis of the conditional probabilities of failure occurrence. C. R. (IAA)

## 07 AIRCRAFT PROPULSION AND POWER

**N85-14965#** Joint Publications Research Service, Arlington, Va.  
**OPTIMUM THERMOGASDYNAMIC DESIGN OF GAS TURBINE ENGINES BY CHARACTERISTICS OF ELEMENT PROTOTYPES**  
**Abstract Only**

Y V KOZHEVNIKOV, V O BOROVNIK, V S IVANOV, V A TALYZIN, I N AGLIULLIN, and Y V MELUZOV *In its* USSR Rept.: Eng and Equipment (JPRS-UEQ-84-007) p 28 14 Nov 1984

Avail. NTIS HC A04/MF A01

Formulas are derived to provide graphic approximations of assigned characteristics of components including low and high pressure compressors and blowers. The parameters of a two stage aircraft engine are optimized. Author

**N85-14967#** Joint Publications Research Service, Arlington, Va.  
**RANDOM VIBRATIONS OF AIRCRAFT ENGINE BLADES**  
**Abstract Only**

A. D. GERSHGORIN and M. L. KEMPNER *In its* USSR Rept Eng. and Equipment (JPRS-UEQ-84-007) p 29 14 Nov 1984 Transl. into ENGLISH from Probl Prochnosti (Kiev), no 1, Jan 1984 p 65-67

Avail. NTIS HC A04/MF A01

A simple model of an aircraft engine blade with long stem and dry friction damping is considered for analysis of flexural vibrations in the plane of rotation under a dynamic load. The blade is treated as a cantilever beam, its mass is lumped at the free end, and the dynamic load is replaced by a centrifugal force acting at the free end as a stationary centered random process. The corresponding equations of motion are solved by the method of statistical linearization, which yields the mean value and the dispersion of flexural stress. Calculations are done for the special case of a blade with uniform stiffness and a white noise perturbation force with infinite spectrum. First considered is a blade without damper and thus motion with one degree of freedom, then a blade with damper at the center and thus motion with two degrees of freedom. In the latter variant the damper is assumed to have a lumped mass equal to that of the blade. The results indicate ways to optimize the damping of random blade vibrations. R J F

## 08

### AIRCRAFT STABILITY AND CONTROL

Includes aircraft handling qualities, piloting; flight controls, and autopilots

**A85-16107#**  
**FLIGHT CONTROL TECHNOLOGY FOR IMPROVED AIRCRAFT PERFORMANCE AND SURVIVABILITY**

R GAYLOR (Sperry Corp., Defense Systems Div., Albuquerque, NM) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, San Diego, CA, Oct 31-Nov. 2, 1984 7 p. refs

(AIAA PAPER 84-2489)

The state-of-the-art in flight control is examined, including the historical development and future prospects. A general fly-by-wire system is discussed with regard to its reliability and backup level requirement. The advantages of fiber optics are discussed including its immunity to lightning and nuclear electromagnetic pulse, and its ability to provide high-speed communications between subsystems and channels of the redundant flight control system. Furthermore, flight control system actuators are discussed, including: conventional low-torque valve, Quadruplex Electronics Signal/Dual Hydraulic Force Motor Control Valve, Quadruplex Actuator with Fiber Optics Interfaces; and Dual Electric Actuator which contains no hydraulic or pneumatic system. Finally, the prospects of applying artificial intelligence to flight control systems are considered. Block diagrams and schematic drawings are included. L T

**A85-16238\*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va  
**ESTIMATION OF AERODYNAMIC FORCES AND MOMENTS ON A STEADILY SPINNING AIRPLANE**

B. N. PAMADI (NASA, Langley Research Center, Hampton, VA, Indian Institute of Technology, Bombay, India) and L. W. TAYLOR, JR. (NASA, Langley Research Center, Hampton, VA) *Journal of Aircraft* (ISSN 0021-8669), vol 21, Dec. 1984, p. 943-954 refs

A semiempirical method is presented for the estimation of aerodynamic forces and moments on a steadily rotating airplane model in a spin tunnel. The approach is based on the application of strip theory to determine a part of the aerodynamic coefficient (including rotational velocity) and then estimation of increments to these coefficients because of rotational flow over the stalled airplane. The theory is applied to a light, single-engine, general aviation airplane and the results are compared with the corresponding spin tunnel rotary balance test data. Author

**A85-17064**

**THE PROBLEM OF DETERMINING THE OPTIMUM FLIGHT CONTROL LAW FOR AN AIRCRAFT [K ZADACHE OPREDELENIIA OPTIMAL'NOGO ZAKONA UPRAVLENIIA POLETOM LETATEL'NOGO APPARATA]**

L. G. ROMANENKO *Aviatsionnaia Tekhnika* (ISSN 0579-2975), no 2, 1984, p. 63-68 In Russian refs

The present paper is an extension of an earlier study (Romanenko, 1982) concerned with the determination of an optimum characteristic polynomial in automatic control systems. In particular, determinations are made of the coefficients of the characteristic polynomials which minimize integral quadratic estimates. The problem of controlling the center of mass of an aircraft in a lateral plane is examined as an example. V L

**A85-17067**

**A SOLUTION TO THE PROBLEM OF THE STABILITY ANALYSIS OF THE THREE-DIMENSIONAL MOTIONS OF FLIGHT VEHICLES [K RESHENIIU ZADACHI ISSLEDOVANIIA USTOICHIVOSTI PROSTRANSTVENNYKH DVIZHENII LETATEL'NYKH APPARATOV]**

T. K. SIRAZETDINOV and A. B. AMINOV *Aviatsionnaia Tekhnika* (ISSN 0579-2975), no. 2, 1984, p. 77-81 In Russian. refs

A method is proposed for the analysis of the stability of the three-dimensional motions of flight vehicles with allowance for the existing cross coupling and nonlinear dependences of the effective forces and moments. The approach proposed here is based on the second Liapunov method. In particular, attention is given to the case where equations of perturbed motion are reduced to a system of ordinary differential equations, with the right term being a polynomial. Examples are included. V.L.

**A85-17230#**

**THIRD GENERATION DIGITAL FLIGHT CONTROLS**

M. RUTHERFORD (CAE Electronics, Ltd., Montreal, Canada) (Royal Aeronautical Society and Canadian Aeronautics and Space Institute, Spring Convention, London, England, May 9, 10, 1984) *Canadian Aeronautics and Space Journal* (ISSN 0008-2821), vol. 30, Sept 1984, p. 249-255

The implementation, realization and testing of digital circuitry for control force feel simulation is outlined. The system was developed using the 767 aircraft control feedback frequencies (200-500 Hz). Circuit gains were software controlled to permit total bandwidth programmability. The force loop employed matched the former analog loop. A control force measurement system gathered flight data for comparison with the simulator performance. The system was further upgraded with a VAX 11/780 computer which allowed selection of a 3.6 kHz forward loop. Installation of a floating point processor enhanced the control dynamic response. Studies are under way to investigate if a 2 kHz response will produce a feel equal to that of an analog simulator, and to reduce the array processor system to a compact, easily maintainable board-based system. M S K



**A85-17810#****TIME FLIES - AN IN-SERVICE EVALUATION OF A 4-D FLIGHT MANAGEMENT SYSTEM**

D A. MOOR (Lockheed-California Co., Palmdale, CA) IN: Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings New York, American Institute of Aeronautics and Astronautics, 1984, p. 54-59.  
(AIAA PAPER 84-2607)

The flight management system (FMS) developed for the L-1011 airliner and certificated in 1977 could position aircraft over an exact geographical location at a precise speed and altitude. The present, 'four-dimensional' FMS adds time as an aircraft control parameter and furnishes automated interface with ATC by automatically positioning the aircraft over a predetermined fix into a terminal area at the exact altitude, speed, and time. It is projected that this capability will significantly expedite the flow of traffic into terminal areas. Attention is given to a six-month in-service evaluation of the 'four-dimensional' FMS conducted by a leading airline, as well as the system's design details. O C

**A85-17819#****BACKUP MODES FOR THE F/A-18 DIGITAL FLIGHT CONTROL SYSTEM**

H E. HARSCHBURGER, B GLASER, and J R HAMMEL (McDonnell Aircraft Co., St Louis, MO) IN Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings New York, American Institute of Aeronautics and Astronautics, 1984, p. 108-115.  
(AIAA PAPER 84-2622)

Configurations and performance requirements incorporated into the F/A-18 fighter back-up quadruply redundant fly-by-wire flight control system are outlined. The system design was driven by reliability, survivability, environment and software verification guidelines. The first two factors were satisfied using known rules for shielding or hardening critical components and adding redundancy. The airframe serves as a Faraday box to shield operations from an aircraft carrier deck environment, which is rife with EM radiation. Software validation was performed in a three step process: modules, integration, and quality assurance reviews. Detailed operational simulations examined the modular assembler programs, the flight control computers exercised the integrated modules, and test results were inspected thoroughly. Only hardware errors have thus far caused reversion to back-up modes during operational performance. M S K

**A85-17820#****INTEGRATED FLIGHT CONTROL/NAVIGATION SENSORS**

R E EBNER and S Y WEI (Litton Systems, Inc., Woodland Hills, CA) IN: Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings New York, American Institute of Aeronautics and Astronautics, 1984, p. 116-123 refs  
(AIAA PAPER 84-2623)

Various programs and techniques being developed for integrating the inertial navigation system (INS) sensors and flight control sensors (FCS) in advanced avionics are described. It is noted that the degree of integration and level of precedence given a sensor is determined by the criticality to flight safety. Attention is being given to the required redundancy in INS sensors, i.e., gyroscopes and accelerometers, and channelized design and filter systems which could reduce the necessary redundancy. The developmental programs, some having reached the flight test stage, are examining dual, quadruple and no attitude and/or velocity sensor redundancy, and nonskewed, skewed, and mixed sensor orientation relative to the aircraft major axes. Some system noise has been experienced during simulations, and the effects of possible transients when switching over to backup sensors are yet to be determined. The simulations have indicated that required performance levels can be met. M S K

**A85-17821#****A HIGHLY MONITORED DIGITAL FLIGHT CONTROL SYSTEM FOR THE AV-8B HARRIER II**

G G GASTON (McDonnell Douglas Corp., St. Louis, MO), L E COSTLOW, and J R PERRY (Sperry Corp., Albuquerque, NM) IN: Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings New York, American Institute of Aeronautics and Astronautics, 1984, p. 124-131  
(AIAA PAPER 84-2624)

The Harrier AV-8B control systems, the stability augmentation and attitude hold system (SAAHS) architecture and operations, SAAHS monitoring methods, and failure transient testing data are outlined. The SAAHS imparts stability during flight below 250 kt airspeed and hover. The SAAHS computer interfaces between the control inputs and control surface actuators, receiving inputs from rate sensors, accelerometers, a stick sensor and a forward pitch amplifier. Separate failure mode monitoring systems are included for in-flight and ground operations. The SAAHS is a single channel system, complete with self-checking routines that satisfy the stringent weight restrictions of the flight control computer for a V/STOL aircraft. M S K

**A85-17822#****MULTIVARIABLE CONTROL SYSTEM DESIGN TECHNIQUES - AN APPLICATION TO A SHORT TAKEOFF AND LANDING AIRCRAFT**

R J LANDY (McDonnell Aircraft Co., St Louis, MO) and D B KIM (Lear Siegler, Inc., Astronics Div., Santa Monica, CA, McDonnell Aircraft Co., St. Louis, MO) IN Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings New York, American Institute of Aeronautics and Astronautics, 1984, p. 132-139  
(AIAA PAPER 84-2625)

A control system design procedure based on multivariable optimization techniques for integrated flight control systems is presented. The method is single value synthesis (SVS), comprising solutions for a sequence of optimization to satisfy a specified open-loop frequency response matrix. The matrix represents the multi-inputs or -outputs. The matrix size is determined by singular values and contains the system state space equations. An input-output relation is defined, along with output error levels within which the output must fall. Maximal and minimal values are thereby extracted for the values which can be generated by the matrix. A step-by-step procedure is worked out as an example, including the system architecture for a landing control system. Further work is required to reduce the controller order to meet the system model requirements for being manageable by an on-board computer. M S K

**A85-17823\*#** National Aeronautics and Space Administration  
Ames Research Center, Moffett Field, Calif

**AIRCRAFT AUTOMATIC DIGITAL FLIGHT CONTROL SYSTEM WITH INVERSION OF THE MODEL IN THE FEED-FORWARD PATH**

G A SMITH and G MEYER (NASA, Ames Research Center, Moffett Field, CA) IN Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings New York, American Institute of Aeronautics and Astronautics, 1984, p. 140-150. refs  
(AIAA PAPER 84-2627)

A full-flight-envelope automatic trajectory control system concept is being investigated at Ames Research Center. This concept was developed for advanced aircraft configurations with severe nonlinear characteristics. A feature of the system is an inverse of the complete nonlinear aircraft model as part of the feed-forward control path. Simulation and flight tests have been reported at previous Digital Avionics Systems conferences. A new method for the continuous real-time inversion of the aircraft model using a Newton-Raphson trim algorithm instead of the original inverse table look-up procedure has been developed. The results of a simulation study of a vertical attitude takeoff and landing aircraft using the new inversion technique are presented. Maneuvers were successfully carried out in all directions in the



vertical-attitude hover mode. Transition runs from conventional flight through the region of lift-curve-slope reversal at an angle of attack of about 32 deg and to hover at zero speed in the vertical attitude showed satisfactory transient response. Simulations were also conducted in conventional flight at high subsonic speed in steep climb and with turns up to 4 g. Successful flight tests of the system with the new model-inversion technique in a UH-1H helicopter have recently been carried out. Author

## A85-17851#

### A METHOD FOR TESTING A DIGITAL FLIGHT CONTROL SYSTEM WITHOUT THE USE OF GROUND SUPPORT EQUIPMENT

H E HANSEN (McDonnell Douglas Corp., St. Louis, MO) IN. Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings New York, American Institute of Aeronautics and Astronautics, 1984, p. 325-331 refs (AIAA PAPER 84-2664)

A number of technological advancements are occurring which could importantly affect the direction of digital flight control system (DFCS) design in the near future. A study for technology evaluation was conducted by an American aerospace company, taking into account as the supporting system the present F-15 Eagle Dual Control Augmentation System (CAS). The present investigation is concerned with the approach employed to transform the F-15 test aircraft into its own self-tester by making use of standard F-15 equipment and adding appropriate software. It is shown that special software can be developed which can utilize equipment resident on the aircraft to accomplish the objective of self-testing. G R

## A85-17859#

### PILOT COMMAND INTERFACES FOR DISCRETE CONTROL OF AUTOMATED NAP-OF-EARTH FLIGHT

S. J. MOUNTFORD, R. PENNER, and P. BURSCH IN. Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings New York, American Institute of Aeronautics and Astronautics, 1984, p. 386-392 refs (AIAA PAPER 84-2621)

It is pointed out that workload levels are excessive in many crewstations. This applies, in particular, to the two-man crew of an attack helicopter performing nap-of-the-earth (NOE) flight. For a number of reasons, it would be desirable to reduce the crew size to that of a single operator. Preliminary workload studies conducted by an American aerospace company on single pilot mission scenarios of scout-attack helicopters indicate that multitask performance during continuous flight control can only be achieved by automating some tasks. The automation of some features of flight control could be one of the prime candidates for implementation. An important human engineering design issue is related to the design of the control interface to allow the pilot to reenter the flight control loop to update flight objectives. The present investigation represents a preliminary attempt to develop some command language interface concepts for integration with an automatic flight control system. G.R.

## A85-18280#

### A DIGITAL SIMULATION STUDY OF 2-DIMENSIONAL FLUTTER ACTIVE SUPPRESSION SYSTEM

Y. YANG Northwestern Polytechnical University, Journal, vol. 2, Oct. 1984, p. 413-420. In Chinese, with abstract in English. refs

A digital simulation method for studying flutter active suppression (FAS) systems is presented. A digital simulation model and a computational method for a two-dimensional FAS system are given. The responses of all elements of a FAS system are determined using the Runge-Kutta method and all eigenvalues are solved using the Q-R method. Four cases are computed and the computed flutter speeds, frequencies, root loci, and responses are shown. The calculated flutter speeds and frequencies agree well with those obtained by other methods. It is concluded that the digital simulation method is useful for studying a FAS system. C.D.

## A85-18332#

### DECOUPLING OF HIGH-GAIN MULTIVARIABLE TRACKING SYSTEMS

D. B. RIDGELY, S. S. BANDA (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH), and J. J. DAZZO (USAF, Institute of Technology, Wright-Patterson AFB, OH) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 8, Jan-Feb 1984, p. 44-49. Previously cited in issue 05, p. 592, Accession no. A83-16625. refs

## A85-18334\*#

### PILOT MODELING AND CLOSED-LOOP ANALYSIS OF FLEXIBLE AIRCRAFT IN THE PITCH TRACKING TASK

D. K. SCHMIDT (Purdue University, West Lafayette, IN) (Guidance and Control Conference, Gatlinburg, TN, August 15-17, 1983, Collection of Technical Papers, p. 491-498) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 8, Jan-Feb 1984, p. 56-61. Previously cited in issue 19, p. 2803, Accession no. A83-41709 refs (Contract NAG1-254)

## A85-18335#

### A FAULT-TOLERANT APPROACH TO HELICOPTER SWASHPLATE CONTROL

B. K. WALKER (MIT, Cambridge, MA), E. GAI, and M. N. DESAI (Charles Stark Draper Laboratory, Inc., Cambridge, MA) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 8, Jan-Feb. 1984, p. 62-70. Research supported by the United Technologies Corp. Previously cited in issue 23, p. 3412, Accession no. A83-48345 refs

## A85-18715

### ROBUST FLIGHT CONTROL FOR CCV AIRCRAFT [ROBUSTE FLUGREGELUNG FUER CCV-FLUGZEUGE]

G. GRUEBEL, H.-D. JOOS, and D. KAESBAUER (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Institut fuer Dynamik der Flugsysteme, Oberpfaffenhofen, West Germany) DFVLR-Nachrichten (ISSN 0011-4901), vol. 43, Nov. 1984, p. 17, 18 In German

Modern aircraft with reduced or lacking stability characteristics are being developed for increasing flight performance. Such aircraft will have to be artificially stabilized by means of a controller. This necessity leads to the development of 'control configured vehicles' (CCV). The concept of 'robust control' represents a new approach for the development of reliable flight controllers for CCV aircraft. 'Robust flight control' implies an employment of controllers with an extremely simple structure. In the absence of gain-scheduling, these controllers can assure a stable flight behavior for an extended flight range. Little use is made of sensors, and a sufficient stability is guaranteed in the case of sensor failure. The Institute for the Dynamics of Flight Systems of the DFVLR is concerned with the development of two complementary procedures for robust control. One procedure involves a design methodology with vectorial quality criterion and parameter optimization. The other approach provides assurance regarding the meeting of stability requirements. G.R.

## N85-13799

### MODEL REDUCTION FOR CONTROL SYSTEM DESIGN Ph.D. Thesis

D. F. ENNS 1984 306 p

Avail.: Univ. Microfilms Order No. DA8420521

An approach and a technique for effectively obtaining reduced order mathematical models of a given large order model for the purposes of synthesis, analysis and implementation of control systems are developed. This approach involves the use of an error criterion which is the H infinity norm of a frequency weighted error between the full and reduced order models. The weightings are chosen to take into account the purpose for which the reduced order model is intended. A previously unknown error bound in the H infinity norm for reduced order models obtained from internally balanced realizations was obtained. This motivated further development of the balancing technique to include the frequency dependent weightings. This resulted in the frequency weighted

balanced realization and a new model reduction technique Two new approaches to designing reduced order controllers were also developed The first involves reducing the order of a high order controller with appropriate weighting The second involves linear quadratic Gaussian synthesis based on a reduced order model obtained with an appropriate weighting. Dissert Abstr.

**N85-13800\*#** Systems Technology, Inc., Hawthorne, Calif.  
**FLYING QUALITIES AND CONTROL SYSTEM CHARACTERISTICS FOR SUPERAUGMENTED AIRCRAFT Final Report**

T T MYERS, D T MCRUER, and D E JOHNSTON Dec. 1984 116 p refs  
 (Contract NAS2-11388)  
 (NASA-CR-170419, NAS 1 26-170419, STI-TR-1202-1) Avail NTIS HC A06/MF A01 CSCL 01C

Aircraft-alone dynamics and superaugmented control system fundamental regulatory properties including stability and regulatory responses of the basic closed-loop systems, fundamental high and low frequency margins and governing factors, and sensitivity to aircraft and controller parameters are addressed Alternative FCS mechanizations, and mechanizational side effects are also discussed An overview of flying qualities considerations encompasses general pilot operations as a controller in unattended, intermittent and trim, and full-attention regulatory or command control, effective vehicle primary and secondary response properties to pilot inputs and disturbances, pilot control architectural possibilities, and comparison of superaugmented and conventional aircraft path responses for different forms of pilot control Results of a simple experimental investigation into pilot dynamic behavior in attitude control of superaugmented aircraft configurations with high frequency time lags and time delays are presented Author

**N85-13801\*#** Calspan Advanced Technology Center, Buffalo, NY

**AN IN-FLIGHT INVESTIGATION OF A TWIN FUSELAGE CONFIGURATION IN APPROACH AND LANDING Final Report, Apr. - Dec. 1983**

N C WEINGARTEN Hampton, Va NASA Langley Research Center Aug. 1984 87 p refs  
 (Contract NASA ORDER L-61966-B, F33615-83-C-3603, F33615-79-C-3618)  
 (NASA-CR-172366, NAS 1.26 172366, CALSPAN-7205-4) Avail NTIS HC A05/MF A01 CSCL 01C

An in-flight investigation of the flying qualities of a twin fuselage aircraft design in the approach and landing flight phase was carried out in the USAF/AFWAL Total In-Flight Simulator (TIFS) The objective was to determine the effects of actual motion and visual cues on the pilot when he was offset from the centerline of the aircraft The experiment variables were lateral pilot offset position (0, 30 and 50 feet) and effective roll mode time constant (6, 12, 24 seconds) The evaluation included the final approach, flare and touchdown Lateral runway offsets and 15 knot crosswinds were used to increase the pilot's workload and force him to make large lateral corrections in the final portion of the approach Results indicated that large normal accelerations rather than just vertical displacements in rolling maneuvers had the most significant degrading effect on pilot ratings The normal accelerations are a result of large lateral offset and fast roll mode time constant and caused the pilot to make unnecessary pitch inputs and get into a coupled pitch/roll oscillation while he was making line up and crosswind corrections A potential criteria for lateral pilot offset position effects is proposed When the ratio of incremented normal acceleration at the pilot station to the steady state roll rate for a step input reaches 01 to 02 g/deg/sec a deterioration of pilot rating and flying qualities level can be expected M G

**N85-14841\*#** National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif

**SIMULATION EVALUATION OF TWO VTOL CONTROL/DISPLAY SYSTEMS IN IMC APPROACH AND SHIPBOARD LANDING**

V K MERRICK Dec 1984 76 p refs  
 (NASA-TM-85996, A-9838; NAS 1 15 85996) Avail NTIS HC A05/MF A01 CSCL 01C

Two control/display systems, which differed in overall complexity but were both designed for VTOL flight operations to and from small ships in instrument meteorological conditions (IMC), were tested using the Ames Flight Simulator for Advanced Aircraft (FSAA) Both systems have altitude command in transition and horizontal-velocity command in hover; the more complex system also has longitudinal-acceleration and flightpath-angle command in transition, and vertical-velocity command in hover The most important overall distinction between the two systems for the viewpoint of implementation is that in one - the more complex - engine power and nozzle position are operated indirectly through flight controllers, whereas in the other they are operated directly by the pilot Simulated landings were made on a moving model of a DD 963 Spruance-class destroyer Acceptable transitions can be performed in turbulence of 3 m/sec rms using either system Acceptable landings up to sea state 6 can be performed using the more complex system, and up to sea state 5 using the other system Author

**N85-14842#** National Aerospace Lab., Tokyo (Japan)

**EXPERIMENTAL STUDY ON TRANSONIC FLUTTER CHARACTERISTICS OF SWEPTBACK WING WITH CORE COMPOSITE PLATES HAVING DIFFERENT FIBER ORIENTATIONS**

K. ISOGAI, H EJIRI, T KIKUCHI, J NAKAMICHI, Y. NOGUCHI, and T MORITA Aug 1984 12 p refs In JAPANESE, ENGLISH summary  
 (NAL-TR-827; ISSN-0389-4010) Avail NTIS HC A02/MF A01

The effects of the fiber orientation on the transonic flutter characteristics of a sweptback wing with a core composite plate are examined experimentally. For this purpose, the two kinds of flutter model having the same planform but different bend-twist characteristics were made; one has a wash-out tendency and the other a wash-in tendency. The wing has an aspect ratio of 5.0, a taper ratio of 0.50 and a leading edge sweep angle of 45 degrees. The airfoil section of this wing is a symmetrical NACA64A010. The flutter models were tested in the National Aerospace Laboratory's 0.6 m x 0.6 m blowdown wind tunnel The flutter boundaries of both the wash-in and wash-out models were determined for a wide range of the transonic Mach numbers. This experiment revealed that the wash-in model shows approx 25 to 30 percent higher flutter velocities than those of the wash-out model over the entire Mach number range tested. B.W

**N85-14844\*#** Draper (Charles Stark) Lab., Inc., Cambridge, Mass.

**ANALYTICAL REDUNDANCY MANAGEMENT MECHANIZATION AND FLIGHT DATA ANALYSIS FOR THE F-8 DIGITAL FLY-BY-WIRE AIRCRAFT FLIGHT CONTROL SENSORS Final Contractor Report, Jul. 1978 - Sep. 1981**

J C DECKERT Apr 1983 61 p refs  
 (Contract NAS4-2675)  
 (NASA-CR-170396, NAS 1 26 170396, CSDL-R-1520) Avail NTIS HC A04/MF A01 CSCL 01C

The details are presented of an onboard digital computer algorithm designed to reliably detect and isolate the first failure in a duplex set of flight control sensors aboard the NASA F-8 digital fly-by-wire aircraft The algorithm's successful flight test program is summarized, and specific examples are presented of algorithm behavior in response to software-induced signal faults, both with and without aircraft parameter modeling errors Author

## 08 AIRCRAFT STABILITY AND CONTROL

**N85-14968#** Joint Publications Research Service, Arlington, Va  
**TERMINAL CONTROL OF GLIDING IN ATMOSPHERE Abstract Only**

V. A. AFANASYEV and T. K. SIRAZETNIVOV *In its USSR Rept: Eng and Equipment (JPRS-UEQ-84-007) p 30 14 Nov 1984*  
Transl. into ENGLISH from Izv Vyssh Ucheb Zaved Aviat Tekhn (Kazan), no 5, Oct-Dec 1983 p 3-9  
Avail NTIS HC A04/MF A01

The problem of controlling gliding of a flight vehicle entering the atmosphere at near circular velocity and landing at a specified point on the ground is examined. Control is accomplished by changing the angular orientation of the flight vehicle by the moments of the forces created by the engines and applied perpendicular to the longitudinal axis. Changing the angular orientation of a flight vehicle changes the trajectory of its center of mass. An example of the simplified control problem is presented in which crude assumptions are refined through iterative synthesis of the control force. R.J.F.

## 09

### RESEARCH AND SUPPORT FACILITIES (AIR)

Includes airports, hangars and runways, aircraft repair and overhaul facilities, wind tunnels, shock tube facilities, and engine test blocks

**A85-16101\*#** National Aeronautics and Space Administration  
Langley Research Center, Hampton, Va  
**NATIONAL TRANSONIC FACILITY SHAKEDOWN TEST RESULTS AND CALIBRATION PLANS**

W. E. BRUCE, JR., D. E. FULLER, and W. B. IGOE (NASA, Langley Research Center, Hampton, VA) American Institute of Aeronautics and Astronautics, Aerodynamic Testing Conference, 13th, San Diego, CA, Mar 5-7, 1984 13 p. refs  
(AIAA PAPER 84-0584)

The results of the shakedown tests and the calibration plan of the National Transonic Facility (NTF) are presented. The facility is designed to operate in both air and nitrogen modes, cover Mach numbers from 0.2 to 1.2, pressures up to 8.8 atm and temperatures between 77 and 339 K. The facility data system is built around four 16-bit minicomputers with a total memory of three megabytes. A portable cryogenic chamber is available. The tunnel systems were operated in a series of tests in Mach number range of 0.2 to 1.17, pressures up to 8.5 atm, and temperatures down to 100 K. The calibration plan includes steady-state and dynamic calibration, as well as wall interference studies. The facility underwent the checkout of the model attitude, plenum isolation, and model access systems, followed by aerodynamic calibration in 1984. Schematic drawings and diagrams are included. L.T.

**A85-16269**  
**AIRCRAFT DELAY IMPACT ON A CENTRAL TERMINAL HALL - A SIMULATION MODEL**

T. JOVANOCIC, M. JELASKA, and M. JANIC (ZG-Prometni Institut, Ljubljana, Yugoslavia) Airport Forum (ISSN 0002-2802), vol. 13, Oct 1984, p. 95-102.

A numerical model is presented for the effect of an air traffic delay on movements in the central hall of an airport terminal. The system considered comprises the air transport, central hall, and land transport segments. Account is taken of the types of aircraft and flights, schedules, and passenger capacities. Passengers arrive at the airport guided by the flight schedules, which may change once they arrive and introduce a random factor into the departure time from the terminal. A distribution is defined for the random variables and used to calculate the number of passengers expected to leave the terminal during a 24 hr period. The model is applied to a typical day at Ljubljana airport, with and without delays. The accuracy of the resulting distributions of delays, passengers waiting within the terminals, and average idle time for the passengers

commends the model for implementation in airport planning

M.S.K.

**A85-17228#**

**MEETING TOMORROW'S STANDARDS WITH YESTERDAY'S SIMULATORS - THE PROBLEMS OF UPGRADING**

T. CORKE (Air Canada, Montreal, Canada) (Royal Aeronautical Society and Canadian Aeronautics and Space Institute, Spring Convention, London, England, May 9, 10, 1984) Canadian Aeronautics and Space Journal (ISSN 0008-2821), vol. 30, Sept. 1984, p. 225-229.

Operational features, problems, and planned and enacted upgrades for the Air Canada L-1011 simulator are described. Coincident purchases of the simulator and L-1011 aircraft caused simulation codes to be different from flight data, mainly due to design changes in the aircraft under construction. Many of the systems simulations then required software changes that took 18 mos. Introduction of a visual system necessitated changes in the radio navigation and flight systems. The visual system eventually needed changes to account for pilot-induced oscillations and reference points. All control feelings were inaccurate until the invention of a hydrostatic control force system. Studies are under way to select a most advantageous method of replacing the 80 k computer currently driving the simulator with a minimum of recoding. Other necessary changes are the bearings in the six-axis motion system and the sound system. M.S.K.

**A85-17232#**

**SIMULATORS/TRAINING DEVICES FOR COMMUTER AIRLINES**

R. L. COLLIE (Regional Airline Association, Washington, DC) (Royal Aeronautical Society and Canadian Aeronautics and Space Institute, Spring Convention, London, England, May 9, 10, 1984) Canadian Aeronautics and Space Journal (ISSN 0008-2821), vol. 30, Sept. 1984, p. 263-268.

The reasons for developing economical simulators for training pilots for flying regional aircraft are delineated, along with standards the simulators must meet. The current cost of simulators is \$5-8 million, too much for regional airlines to pay, while at the same time the pilots must learn during actual flights, an expensive school in which to gain all proficiency skills. The rapid expansion of regional services and numbers of passengers carried in the period 1972-1982 has placed a heavy burden of in-flight training on existing, operational aircraft. It is suggested that a motion-equipped, non-visual simulator can be built for \$0.75 million. The device would furnish line-oriented flight training and cockpit resource management skills. Detailed requirements for Levels I-III simulators which would meet FAA standards have been defined and can be tailored to any specific aircraft. The equipment specifications and performance test, tolerance and characteristics at each level are outlined. M.S.K.

**A85-17240**

**THE EUROPEAN TRANSONIC WIND-TUNNEL ETW - A CRYOGENIC SOLUTION**

J. P. HARTZUIKER (European Transonic Wind-tunnel, Amsterdam, Netherlands) Aeronautical Journal (ISSN 0001-9240), vol. 88, Nov 1984, p. 379-394. refs

The governments of France, West Germany, the Netherlands and Britain are cooperating under a memorandum of understanding to build a high Reynolds number transonic wind tunnel test facility of the cryogenic type. Attention is presently given to the development of the European Transonic Wind tunnel (ETW), together with its pilot (PETW) wind tunnel and model design and instrumentation technology for cryogenic conditions. The ETW will be a closed circuit tunnel with continuous drive, whose high Reynolds numbers will be achieved by injecting liquid nitrogen to decrease working temperatures. The test section configuration is of the slotted wall type, although the design allows future retrofitting of adaptive walls. The PETW will be a 1/8.8-scale version of the ETW and will first be operated at its location in the Netherlands in February, 1984. O.C.

**A85-17852#****REAL TIME DATA PROCESSING FOR AVIONICS TESTING ON THE A-6E**

P. T. RICHARDS and J. LEHMANN (Grumman Data Systems Corp., Calverton, NY) IN: Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings New York, American Institute of Aeronautics and Astronautics, 1984, p 332-338

(AIAA PAPER 84-2666)

Results to date on implementing a real-time avionics test program using the A-6E all-weather attack aircraft are reported. The A-6E's 16-bit weapon system computer data is serialized and telemetered to ground computers. Three data streams are sent: track-while-scan, local INS data, and atmospheric data. The weapon delivery system mainly uses the data for air-ground missiles. Time and space multiplexing permits data compressions, while the received data are converted into engineering units, labelled, displayed in suitable formats for observers, and stored on tape. Faulty instrumentation is immediately detected, as are erroneous flight conditions and bugs in the embedded code. A savings of approximately 20 percent is realized in the development of weapons systems delivery. Various standard programs employed in the real-time data processing are outlined.

M.S.K.

**A85-17853#****SAFETY-OF-FLIGHT AND QUALIFICATION TESTING FOR AVIONIC SYSTEMS**

W. J. HALL, JR. (General Dynamics Corp., Fort Worth, TX) IN: Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings New York, American Institute of Aeronautics and Astronautics, 1984, p 339-345

(AIAA PAPER 84-2670)

A series of safety-of-flight (SOF) tests for military avionics systems is described. The tests are designed to ensure that the aircraft electronics equipment is compatible with operation in a variety of hostile environments. Some of the specific phenomena examined in SOF tests include: gun vibration acoustic noise; fungus resistance, EMI-EMP resistance, explosive decompression, moisture and rain resistance, and a number of structural tests for electronic instrument housings. Emphasis is given to the importance of sequencing safety tests correctly so that results are not invalidated.

I.H.

**A85-18501#****T2 WIND TUNNEL ADAPTIVE WALLS - DESIGN, CONSTRUCTION AND SOME TYPICAL RESULTS**

J. P. CHEVALLIER (ONERA, Chatillon-sous-Bagneux, Hauts-de-Seine, France), A. MIGNOSI, J. P. ARCHAMBAUD, and A. SERAUDIE (ONERA, Centre d'Etudes et de Recherches de Toulouse, Toulouse, France) La Recherche Aeronautique (English Edition) (ISSN 0379-380X), no. 4, 1983, p 1-19 refs

The development of adaptive walls requires a detailed analysis of basic principles concerning the coupling between the internal field (test section) and the external one (freestream computation) as well as the necessity of carrying out a fast-converging process and of defining an accurate reference velocity. The application of the T2 wind tunnel is then described, specifying the control tests used for the adaptive wall operation and the technological means developed for automatic adaptation in a single run. Finally, results are presented which show the quality of the tests emphasizing several experimental problems (side wall boundary layers, pressure hole diameters, boundary layer transition, etc).

Author

**A85-18714****THE NEED FOR SYSTEM IDENTIFICATION IN FLIGHT MECHANICS, TAKING INTO ACCOUNT THE BENEFITS OF SUCH AN IDENTIFICATION [BEDARF UND NUTZEN DER SYSTEMIDENTIFIZIERUNG IN DER FLUGMECHANIK]**

K.-F. DOHERR and R. KOEHLER (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Institut fuer Flugmechanik, Brunswick, West Germany) DFVLR-Nachrichten (ISSN 0011-4901), vol 43, Nov 1984, p 12-16 In German

The dynamic behavior of an aircraft is described by certain characteristic values. These system parameters provide a basis for simulation operations which make it possible to predict, even in the design stage, the flight characteristics of the aircraft. This possibility has led to the development of the discipline of system identification. The discipline has the objective to formulate processes of motion and to determine numerical values for the parameters of motion on the basis of experimental data. The Institute of Flight Mechanics of the DFVLR is concerned with developments related to system identification. Research results have led to cooperation on a national and international basis. Attention is given to the principles of system identification, questions of identifiability, the selection of optimal input signals, linear and nonlinear estimation procedures, identification in the frequency domain, equivalent systems of low order with dead time, and new procedures which will have to be developed in connection with the continuing extension of the application of system identification.

G.R.

**A85-18723****ETW, THE EUROPEAN CRYOGENIC WIND TUNNEL WILL BE BUILT IN COLOGNE, WEST GERMANY [ETW, SOUFFLERIE CRYOGENIQUE EUROPEENNE SERA CONSTRUITE EN ALLEMAGNE A COLOGNE]**

J. MORISSET Air et Cosmos (ISSN 0044-6971), vol 22, Dec 15, 1984, p 24, 25. In French

It is expected that an intergovernmental agreement will soon be completed to produce a final design for the ETW, which has been under study since 1978. The project will be one of cooperation among the United Kingdom, West Germany, the Netherlands, and France. Costing an estimated 1.4 billion francs, the facility will allow studies of Mach 0.9 flows at Re up to 50 million, i.e., just over that experienced by the Airbus 300. The wind tunnel will have a 2.4 x 2 m chamber, function from 1.25-4.5 bars and at temperatures from -183 to +40 C, and will furnish flows of Mach 0.15-1.3 with liquid nitrogen as the ambient medium. The flow will be driven by a 45 MW motor and the tunnel will be 120 m long. A smaller, pilot ETW has recently entered service in Amsterdam.

M.S.K.

**A85-18868****MODERN ANNOUNCEMENT METHODS IN AIR TERMINALS [PROCEDES MODERNES DE SIGNALISATION DANS LES AEROGARES]**

E. SAUVALLÉ (Aéroports de Paris, Paris, France) Revue Generale des Routes et des Aerodromes (ISSN 0035-3191), vol. 58, Nov 1984, p 12-14, 16 In French

Air terminals need annunciator equipment which will aid in efficient passenger and baggage transit and terminal operations which ensure optimal use of aircraft. Flight departures and arrivals are listed either on large screen televisions, rollers with printed plates, or printed disks or cylinders. LCD and electroluminescent panels are being studied, although poor contrast appears to limit the applicability of LCDs. The placement of the annunciator is significant in choosing the type to be used due to the considerations of the available space and projected number of viewers. Details of the television display system of the new Charles de Gaulle airport terminal are outlined, noting that the system is divided into passenger and service grids under centralized control. A total of 445 CRT screens display information generated by the CAPEX central data processor.

M.S.K.

## 09 RESEARCH AND SUPPORT FACILITIES (AIR)

A85-18869

### THE NEW JAKARTA INTERNATIONAL AIRPORT [LE NOUVEL AEROPORT INTERNATIONAL DE JAKARTA]

C. J. C. BUSSON Revue Generale des Routes et des Aerodromes (ISSN 0035-3191), vol 58, Nov. 1984, p. 17-20, Discussion, p 21. In French

The first phase of construction of the international airport near Jakarta was scheduled for completion at the end of 1984, leading to handling of 9,000,000 passengers in 1985. Situated on old volcanic deposits and rice plantations, the facility cost over 2 billion francs and includes concrete runway surfaces laid on crushed coral mined from nearby islands. Two new ports were built to accommodate the incoming material and machinery. The land was drained by digging canals and concrete pilings were sunk to support the main structures. The airport has a 3660 and a 3050 m runways, each 60 m wide, three terminals, exterior parking for 2400 vehicles, two cargo terminals, and DVOR/DME/ILS nav aids. The arrangement of the terminals permits simultaneous parking of 21 large transport aircraft. M.S.K

A85-18870

### AERONAUTICAL ROADWAYS - PECULIARITIES OF AIRPORT RUNWAYS [LES CHAUSSEES AERONAUTIQUES - PARTICULARITES DES CHAUSSEES D'AERODROMES]

Y. CAMARES (Direction Generale a l'Aviation Civile, Service Technique des Bases Aeriennes, Paris, France) and P. LAURUOL (Societe Francaise d'Etudes et de Realisations d'Equipements Aeronautiques, Paris, France) Revue Generale des Routes et des Aerodromes (ISSN 0035-3191), vol. 58, Nov. 1984, p. 36-40 In French

Characteristics of airport roadways which distinguish them from land vehicle roads are noted. Runways are built to accommodate particular kinds of loads, i.e., the weight of aircraft, tire pressure, frequency of use, landing contact and graduated takeoff forces, and the speeds encountered. Larger airports require thicker runways, while all runways must be tailored to meet the expected traffic. Runway construction requires consideration of the fatigue and the grain of the surface and the shifting of the runway segments at the seams. The runway must be raised without sloping so water does not collect and the subsurface must not absorb water. The construction must include provisions for repairs/upgrades during hours when the airport is closed and continuous use during operational hours. The runway needs to resist damage from leaked aircraft fuels and jet exhausts while protecting interior cabling for the runway lighting from operational and environmental degradation. M.S.K

A85-18871

### AERONAUTICAL ROADWAYS - PUBLICATION OF ADMISSIBLE LOADS: THE NEW ACN/PCN METHOD [LES CHAUSSEES AERONAUTIQUES - PUBLICATION DES CHARGES ADMISSIBLES: LA NOUVELLE METHODE ACN/PCN]

Y. CAMARES (Direction Generale a l'Aviation Civile, Service Technique des Bases Aeriennes, Paris, France) and P. LAURUOL (Societe Francaise d'Etudes et de Realisations d'Equipements Aeronautiques, Paris, France) Revue Generale des Routes et des Aerodromes (ISSN 0035-3191), vol 58, Nov. 1984, p. 40-42 In French.

The aircraft classification number/pavement classification number (ACN/PCN) method of determining acceptable loads for runway surfaces became internationally accepted in 1981. Each type of aircraft is categorized by its nominal full weight. Consideration is given to the runway subsurface conditions and flexible or rigid runway surface. The surface quality value is set by nationally-determined standards. The ability of an aircraft to use a particular runway is then a matter of the ACN/PCN ratio: if more than one, then no, if less than unity, then yes. Options for rating the runways are discussed. M.S.K

A85-18872

### AERONAUTICAL ROADWAYS - THE FRENCH METHOD OF EVALUATING THE LOADBEARING CAPABILITY OF AERONAUTICAL ROADWAYS [LES CHAUSSEES AERONAUTIQUES - METHODE FRANCAISE D'EVALUATION DE LA PORTANCE DES CHAUSSEES AERONAUTIQUES]

Y. CAMARES (Direction Generale a l'Aviation Civile, Service Technique des Bases Aeriennes, Paris, France) and P. LAURUOL (Societe Francaise d'Etudes et de Realisations d'Equipements Aeronautiques, Paris, France) Revue Generale des Routes et des Aerodromes (ISSN 0035-3191), vol 58, Nov. 1984, p. 42-49, Discussion, p. 49, 50 In French.

French techniques for evaluating the load-carrying capabilities of runways are explored. The capabilities must allow for future aircraft and are determined on the bases of the soil-runway structural characteristics and the necessity of operational safety. Dimensional and other NDE methods are employed for the analyses. The dimensioning method consists of categorizing the soil compactness, the number of runway layers and their thicknesses and materials. The runways are normally dimensioned for a 10 yr lifetime. The expected loads can also be determined by combinations of plates, where the runway response is projected, together with the effects of repeated loadings. Another method is to haul 20,000 kg of water in a trailer onto a runway, use the water to hydraulically impart an abrupt pulse pressure using a plate, on the runway, and touch the runway with sensors at specified distances to monitor the surface displacements. The method is suitable for runways which have been previously surveyed. Finally, techniques used for overseas French airports are described. M.S.K

A85-18873

### REINFORCEMENTS FOR AERONAUTICAL ROADWAYS [LES RENFORCEMENTS DE CHAUSSEES AERONAUTIQUES]

N. GONTIER (Aeroports de Paris, Paris, France) Revue Generale des Routes et des Aerodromes (ISSN 0035-3191), vol 58, Nov. 1984, p. 61-64 In French

Techniques employing locally available materials to repair runways or upgrade them to handle new types of aircraft are described. It is noted that the ubiquitous 747 is driving the need to upgrade existing runways to handle heavier loads. Runways under constant use usually exhibit gutters, crumbling and cracking. Repairs/reinforcements can be effected after calculating the necessary strengths according to standard FAA formulas. Sample solutions implemented to upgrade or repair the runway surfaces at the Cameroon, Mauritania Island, and Guinea airports are described, noting that tropical rains falling on a still-hot surface can be somewhat ameliorated by a coating which decreases the large temperature swings of the surface material. M.S.K

N85-13803# New Mexico Univ., Albuquerque. Engineering Research Inst.

### ALTERNATIVES FOR RUNWAY RUBBER REMOVAL FROM POROUS FRICTION SURFACES

R. G. MCKEEN and L. R. LENKE Washington FAA Jul 1984 15 p refs Prepared in cooperation with Air Force Engineering and Services Center (DOT/FAA/PM-84/28, ESL-TR-84-46) Avail: NTIS HC A02/MF A01

The touchdown areas of runways serving high-speed modern aircraft are subjected to impact by the tires during landing. A certain amount of rubber is removed due to heat and abrasion as aircraft tires spin up during landing. Rubber is deposited on the pavement surface as thin layers that adhere to the pavement materials. Subsequent rubber deposits increase the buildup to significant layer thicknesses. As the touchdown area becomes covered with rubber several problems are apparent. They are (1) obliteration of pavement markings, (2) reduced wet skid resistance, and (3) accumulation of loose debris on the runway surface. Maintenance action is required to eliminate or reduce these problems to acceptable levels. Painting of pavement markings is a regular activity at all active airports; sweeping of runways is performed to remove loose debris, and rubber removal is performed

to restore skid characteristics of the pavement surface. This report is concerned specifically with the problems involved in removal of rubber deposits from porous friction course (PFC) or porous friction surface (PFS). B.W

## 10

## ASTRONAUTICS

Includes astronautics (general), astrodynamics, ground support systems and facilities (space); launch vehicles and space vehicles, space transportation, spacecraft communications, command and tracking, spacecraft design, testing and performance; spacecraft instrumentation, and spacecraft propulsion and power.

**N85-13804#** Department of the Navy, Washington, D. C.  
**PREFABRICATED PANELS FOR RAPIDLY RUNWAY REPAIR AND EXPEDIENT AIRFIELD SURFACING** Patent Application  
P. S. SPRINGSTON and R. L. CLAXTON, inventors (to Navy)  
17 Jul 1984 14 p  
(AD-D011277, US-PATENT-APPL-SN-631954) Avail NTIS HC A02/MF A01 CSCL 01E

Low profile portable panels consisting of fiberglass-reinforced plastic composite mats which include hollow in-organic silica spheres in the plastic resin to reduce weight have recessed molded lips and bushings along all edges for connecting panels together with bolts to form expedient airfield surfacing and repair having high flexural strength and high structural capacity. GRA

**N85-14846#** Kinton, Inc., Alexandria, Va.  
**SITUATIONAL INTERACTIVE MICRO/GRAPHIC SIMULATOR SYSTEM FOR IMPROVING MAINTENANCE PERFORMANCE**  
Final Technical Paper, Jan. 1980 - Jan. 1983  
E. L. SHRIVER and R. C. TREXLER Brooks AFB, Tex AFHRL  
Sep. 1984 144 p  
(Contract F33615-80-C-0012)  
(AD-A146677, AFHRL-TP-84-9) Avail NTIS HC A07/MF A01 CSCL 05I

A generic hardware trainer tester was constructed using a microcomputer, two image storage/display devices, a magnetic and reader, a data entry keypad, and a printer. Problem-solving courseware was developed based on situational interaction techniques. Thirty problems simulated troubleshooting the major components of the FB-111A flight simulator. Students solved each problem by forming their hypotheses about the source of trouble, abstracting data from the displays/test instruments they chose to observe, and reformulating their hypotheses as needed. They completed the problem-solving process by replacing the malfunctioning part and verifying that this replacement cleared all symptoms. Some problems were multiple malfunctions. Fifteen newly assigned personnel had to find and correct malfunctions placed in the actual equipment, given only the AFTO Form 781 work order which stated a symptom of the problem. The six simulator-experienced personnel were consistent in taking steps that led directly to problem solution. None of the personnel who lacked simulator experience were consistent, all took irrelevant steps. Job supervisors look for consistent performance before trusting performers in order to avoid damage to themselves or the equipment. In effect, the simulator training reduces the time it takes new personnel to become consistent job performers. GRA

**A85-17052**

**THE EFFECT OF PARAMETER SCATTER ON THE QUALITY INDICES OF A FLIGHT VEHICLE PLATFORM STABILIZATION SYSTEM** [O VLIIANII RAZBROSA PARAMETROV NA POKAZATELI KACHESTVA SISTEMY STABILIZATSII PLATFORMY LETATEL'NOGO APPARATA]

IU. V. ALEKSANDROV, V. I. GARKUSHENKO, and N. N. MALIVANOV Aviatsonnaia Tekhnika (ISSN 0579-2975), no. 2, 1984, p. 8-11. In Russian. refs

The study is concerned with the synthesis and sensitivity analysis of a system for stabilizing the platform of a flight vehicle relative to the center of suspension in a vertical plane. The method of successive approximations is used to analyze the guaranteed sensitivity of the quality vector of the system in a specified parameter scatter region. The need for a coordinate-parametric platform control system including an imbalance stabilization loop is demonstrated. V L

**A85-18338#**

**OPTIMAL SIMULTANEOUS STRUCTURAL AND CONTROL DESIGN OF MANEUVERING FLEXIBLE SPACECRAFT**

A. L. HALE, W. E. DAHL (Illinois, University, Urbana, IL), and R. J. LISOWSKI (U.S. Air Force Academy, Colorado Springs, CO, Illinois, University, Urbana, IL) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 8, Jan-Feb 1984, p. 86-93. refs

An optimization problem for maneuvering flexible spacecraft is discussed wherein both structural parameters and active control forces are to be determined so that a specific cost functional is minimized. The problem is an application of the general theory of optimal control of parametric systems. For simplicity, only maneuvers from a specified initial state to a specified final state in a specified time interval are considered. Numerical examples are presented for single-axis slew maneuvers of a symmetric four-boom flexible structure. The mass and stiffness distributions of the booms are determined as part of the optimization problem.

Author

**A85-18674\*** National Aeronautics and Space Administration  
Ames Research Center, Moffett Field, Calif  
**SECOND-ORDER P-ITERATIVE SOLUTION OF THE LAMBERT/GAUSS PROBLEM**

F. W. BOLTZ (NASA, Ames Research Center, Moffett Field, CA) Journal of the Astronautical Sciences (ISSN 0021-9142), vol. 32, Oct.-Dec 1984, p. 475-485. refs

An algorithm is presented for efficient p-iterative solution of the Lambert/Gauss orbit-determination problem using second-order Newton iteration. The algorithm is based on a universal transformation of Kepler's time-of-flight equation and approximate inverse solutions of this equation for short-way and long-way flight paths. The approximate solutions provide both good starting values for iteration and simplified computation of the second-order term in the iteration formula. Numerical results are presented which indicate that in many cases of practical significance (except those having collinear position vectors) the algorithm produces at least eight significant digits of accuracy with just two or three steps of iteration. Author

**A85-18817\*** National Aeronautics and Space Administration John F. Kennedy Space Center, Cocoa Beach, Fla.

## **ORBITER SPACECRAFT WEIGHT AND CENTER OF GRAVITY DETERMINATION**

J. G. FRALEY (NASA, Kennedy Space Center, Cocoa Beach, FL) Society of Allied Weight Engineers, Annual Conference, 42nd, Anaheim, CA, May 23-25, 1983. 23 p (SAWE PAPER 1559)

This paper describes the procedure for determination of the weight and the location of the center of gravity (c g) of a Space Shuttle Orbiter Spacecraft, at the Kennedy Space Center, Florida. This task is performed at the completion of the horizontal processing of each Orbiter in conjunction with jack down and preparation for vertical mating to the Shuttle launch vehicle. The operation is performed in the Orbiter Processing Facility. The paper contains a brief description of the general characteristics and physical dimensions of the Orbiter spacecraft, the program requirements and test procedure for weight and c g. determination, data evaluation and a summary. Author

**N85-14853** Department of the Army, Washington, D. C.

## **FAST RESPONSE IMPULSE GENERATOR Patent**

E. R. CAPONI, inventor (to Army) 24 Apr 1984 3 p (AD-D011283, US-PATENT-4,444,119; US-PATENT-APPL-SN-394566; US-PATENT-CLASS-102-530) Avail. US Patent and Trademark Office CSCL 10A

This abstract describes an impulse generator for providing an impulsive force substantially normal to the axis of a missile to provide the missile with the desired angle of attack. The device includes radial explosive paths to its periphery and from each point on the periphery detonation is transferred to the periphery of the main charge causing it to implode. Author (GRA)

**N85-14859** Department of the Air Force, Washington, D C

## **COMBINED CYCLE RAMJET ENGINE Patent**

J. R. SMITH, inventor (to Air Force) 10 Apr. 1984 6 p Supersedes AD-D006308 (AD-D011247, US-PATENT-4,441,312, US-PATENT-APPL-SN-051315, US-PATENT-CLASS-60-245) Avail. US Patent and Trademark Office CSCL 21H

The metallic wall of the combustion chamber of a combined rocket-ramjet engine is lined with solid ramjet fuel overlaid with rocket fuel. After the consumption of the rocket fuel in the boost portion of the flight the solid ramjet fuel burns and ablates protecting the metallic combustion chamber wall from high temperatures during the cruise phase of the missile flight. Author (GRA)

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## CHEMISTRY AND MATERIALS

Includes chemistry and materials (general), composite materials; inorganic and physical chemistry; metallic materials; nonmetallic materials; and propellants and fuels.

**A85-16033**

## **EVALUATION OF KEVLAR 29 FOR FILAMENT-WOUND STRUCTURAL APPLICATIONS IN HELICOPTER**

K. A. COLLINS, D. W. HUFF, and J. E. SCHIBLER (Hughes Helicopters, Inc., Culver City, CA) IN: Technology vectors; Proceedings of the Twenty-ninth National SAMPE Symposium and Exhibition, Reno, NV, April 3-5, 1984. Covina, CA, Society for the Advancement of Material and Process Engineering, 1984, p 859-869

The testing techniques and results from an examination of Kevlar 29 as a material for helicopter blades are described. The trials were performed on both coconut-oil soaked and nonsoaked fibers. The oil serves to inhibit inter-laminate friction, but also reduces adhesion between the fibers and matrix. The tests comprised impregnated strands, in-plane and interlaminar shears,

flexural loading and fatigue trials, all involving 1500 denier rovings. Kevlar 29 was concluded a viable material for primary structures, although higher strain resins are needed to match the fiber capabilities. The commonly applied oil-finish was found unsuitable for structural applications. M.S.K.

**A85-16050**

## **FILAMENT WINDING OF AIRCRAFT ENGINE NACELLE COMPONENTS**

M. E. HUBER (Rohr Industries, Inc., Riverside, CA) IN: Technology vectors; Proceedings of the Twenty-ninth National SAMPE Symposium and Exhibition, Reno, NV, April 3-5, 1984. Covina, CA, Society for the Advancement of Material and Process Engineering, 1984, p. 1184-1195

Filament winding of aircraft engine nacelle components, while being a logical concept, represents a totally new approach for production manufacture. Historically, filament winding has not involved thin walled structures, therefore, this application challenged previous 'state-of-the-art' in winding technology. The new developments to overcome these challenges are discussed. The advantages of this technique and its major considerations are also outlined. These advantages include repeatability, and savings in time, labor, and cost. The prime aspects for review include the design, material selection, process techniques, and surface finish. Author

**A85-16052**

## **NEW HIGH TEMPERATURE AND FUEL RESISTANT SEALANTS BASED ON PERMAPOL (TRADEMARK) P-3, POLYTHIOETHER POLYMERS**

J. W. HUTT and H. SINGH (Products Research and Chemical Corp., Grendale, CA) IN: Technology vectors, Proceedings of the Twenty-ninth National SAMPE Symposium and Exhibition, Reno, NV, April 3-5, 1984. Covina, CA, Society for the Advancement of Material and Process Engineering, 1984, p 1204-1212

The chemical characteristics and applications of Permapol P-3 polymers as sealants are described. P-3 polymers have no sulfur links above first order, thereby having enhanced thermal stability relative to other polymers. Furthermore, the absence of repeating formal linkages gives good hydrolytic stability. Tests have shown over 40 percent strength retention after 42 days in 200 F water. P-3 based urethanes are of use as aircraft fuel bag sealants. When combined with epoxy, P-3 is suitable as a high performance fuel resistant adhesive and sealant. M.S.K.

**A85-16085#**

## **INTRODUCTION OF TITANIUM POWDER METALLURGY COMPONENTS TO AIRCRAFT SERIES PRODUCTION**

W. KEINATH (Messerschmitt-Boelkow-Blohm GmbH, Ottobrunn, West Germany) and J. ENGELS (Messerschmitt-Boelkow-Blohm GmbH, Hamburg, West Germany) Deutsche Gesellschaft fuer Metallkunde, Metallurgical Society of AIME, Akademia Nauk SSSR, et al., International Conference on Titanium, 5th, Munich, West Germany, Sept. 10-14, 1984, Paper 6 p (MBB-BB-569-84-OE)

The successful development of a powder metallurgy (PM) HIP component from a TiAl6V4 titanium alloy, and the possibility of introducing the component to series production, is demonstrated in an airframe component. The development, design, and manufacture of the PM HIP component are described, and the results of tensile and dynamic tests on the component are reported. Series production will reduce production costs of the component by 34 percent. C.D.



A85-16949

**THE DETERMINATION OF BIOLOGICAL IMPURITIES IN FUELS [OPREDELENIE BIOLOGICHESKIKH ZAGRIAZNENII V TOPLIVAKH]**V B SKRIBACHILIN, E A LAPTEVA, and L K MIKHAILOVA  
Khimia i Tekhnologiya Topliv i Masel (ISSN 0023-1169), no 11, Nov 1984, p 16-18 In Russian refs

Microbiological analytical methods, which are usually employed for the determination of biological impurities in fuels, provide insufficient objective information regarding the nature of the impurities. In order to obtain reliable data, it is necessary to use methods which take into account the external conditions and the composition of the biological substances. The characteristics of the external conditions and the composition of biomass have been considered, and a number of methods have been employed to study sediments in various types of fuels. The considered fuels include aircraft fuel TC-1. The properties of the fuels studied are presented in a table, taking into account aspects of appearance, the presence of bioagents, and the characteristic elements. G R

A85-16950

**THE EFFECT OF ESTERS ON 'ANTIWEAR' PROPERTIES OF JET ENGINE FUEL OBTAINED BY HYDROFINING [VLIANIE EFIROV NA PROTIVOIZNOSNYE SVOISVA GIDROOCHISHCHENNOGO REAKTIVNOGO TOPLIVA]**

A S KISLENKO, I F KRYLOV, T P VISHNIAKOVA, and G I SOKOLOVA (Moskovskii Institut Neftekhimicheskoi i Gasovoi Promyshlennosti, Moscow, USSR) Khimii i Tekhnologii Topliv i Masel (ISSN 0023-1169), no. 11, Nov 1984, p. 27-29 In Russian refs

The present investigation is concerned with jet engine fuels which can be used for an operation involving a minimization of wear regarding the engine. One approach for improving the 'antiwear' properties of jet engine fuels obtained as a product of hydrofining involves the addition of compounds containing various functional groups, including those related to esters. However, no information is found in literature regarding the relation between the improvement in 'antiwear' properties provided by the esters and the ester composition, taking into account the presence of other functional groups. The present investigation is concerned with the effect of a number of synthesized compounds on the 'antiwear' properties of jet engine fuels. These compounds are esters of stearic acid with polyhydroxy alcohols, including ethylene glycol, diethylene glycol, and glycerol. Differences regarding the effectiveness of various compounds in promoting 'antiwear' properties in fuels can be explained by taking into account the position of hydroxyl and ester groups. G R

A85-19099

**AN OVERVIEW OF POTENTIAL FOR THE SUBSTITUTION OF CERAMIC MATERIALS FOR VULNERABLE MATERIALS AND THE IMPLICATIONS OF NATIONAL MATERIALS POLICY**

J I MUELLER (Washington, University, Seattle, WA) Materials and Society (ISSN 0146-6399), vol 8, no 2, 1984, p 381-391 refs

A comprehensive evaluation is presented of the primary fields of applications development, as well as the performance and economic gains foreseen, in the substitution of ceramic materials for strategic metallic materials. Attention is given to the replacement by silicon carbide and silicon nitride structural ceramics of nickel-base alloys currently employed in large quantities in gas turbine engine hot section components. The ceramics in such applications would be less expensive, more tolerant of chemically severe environments, and significantly less dense. Forecasts are made for structural ceramic market penetrations by the year 2000 in such cases as diesel and gas turbine components, bearings, and turbochargers. Comparisons are also made between prospective gains for structural ceramics and the already maturing electronics ceramics. An especially heavy commitment to the development and use of structural ceramics is noted for Japan. O C

**N85-13912\*# Boeing Commercial Airplane Co., Seattle, Wash FULL-SCALE TESTING, PRODUCTION AND COST ANALYSIS DATA FOR THE ADVANCED COMPOSITE STABILIZER FOR BOEING 737 AIRCRAFT. VOLUME 1: TECHNICAL SUMMARY Final Report**R B ANIVERSARIO, S T HARVEY, J E MCCARTY, J T PARSONS, D C PETERSON, L D PRITCHETT, D R WILSON, and E R WOGULIS NASA Apr 1983 32 p  
(Contract NAS1-15025)  
(NASA-CR-3649, NAS 1 26 3649, D6-46038-1-VOL-1) Avail  
NTIS HC A03/MF A01 CSCL 11D

The full scale ground test, ground vibration test, and flight tests conducted to demonstrate a composite structure stabilizer for the Boeing 737 aircraft and obtain FAA certification are described. Detail tools, assembly tools, and overall production are discussed. Cost analyses aspects covered include production costs, composite material usage factors, and cost comparisons. A R H

**N85-13913\*# Boeing Commercial Airplane Co., Seattle, Wash DESIGN, ANCILLARY TESTING, ANALYSIS AND FABRICATION DATA FOR THE ADVANCED COMPOSITE STABILIZER FOR BOEING 737 AIRCRAFT. VOLUME 1: TECHNICAL SUMMARY Final Report**R B ANIVERSARIO, S T HARVEY, J E MCCARTY, J T PARSONS, D C PETERSON, L D PRITCHETT, D R WILSON, and E R WOGULIS NASA Apr 1983 59 p refs  
(Contract NAS1-15025)  
(NASA-CR-3648, NAS 1 26 3648, D6-46037-1-VOL-1) Avail  
NTIS HC A04/MF A01 CSCL 11D

The horizontal stabilizer of the 737 transport was redesigned. Five shipsets were fabricated using composite materials. Weight reduction greater than the 20% goal was achieved. Parts and assemblies were readily produced on production-type tooling. Quality assurance methods were demonstrated. Repair methods were developed and demonstrated. Strength and stiffness analytical methods were substantiated by comparison with test results. Cost data was accumulated in a semiproduction environment. FAA certification was obtained. A R H

**N85-13914\*# Boeing Commercial Airplane Co., Seattle, Wash DESIGN, ANCILLARY TESTING, ANALYSIS AND FABRICATION DATA FOR THE ADVANCED COMPOSITE STABILIZER FOR BOEING 737 AIRCRAFT, VOLUME 2 Final Report**R B ANIVERSARIO, S T HARVEY, J E MCCARTY, J T PARSONS, D C PETERSON, L D PRITCHETT, D R WILSON, and E R WOGULIS Dec 1982 400 p  
(Contract NAS1-15025)  
(NASA-CR-166011, NAS 1 26:166011; D6-46037-2-VOL-2) Avail  
NTIS HC A17/MF A01 CSCL 11D

Results of tests conducted to demonstrate that composite structures save weight, possess long term durability, and can be fabricated at costs competitive with conventional metal structures are presented with focus on the use of graphite-epoxy in the design of a stabilizer for the Boeing 737 aircraft. Component definition, materials evaluation, material design properties, and structural elements tests are discussed. Fabrication development, as well as structural repair and inspection are also examined. A R H

**N85-13915\*# Boeing Commercial Airplane Co., Seattle, Wash FULL-SCALE TESTING, PRODUCTION AND COST ANALYSIS DATA FOR THE ADVANCED COMPOSITE STABILIZER FOR BOEING 737 AIRCRAFT, VOLUME 2 Final Report**R B ANIVERSARIO, S T HARVEY, J E MCCARTY, J T PARSONS, D C PETERSON, L D PRITCHETT, D R WILSON, and E R WOGULIS Dec 1982 102 p refs  
(Contract NAS1-15025)  
(NASA-CR-166012; NAS 1 26 166012, D6-46038-2-VOL-2) Avail  
NTIS HC A06/MF A01 CSCL 11D

The development, testing, production activities, and associated costs that were required to produce five-and-one-half advanced-composite stabilizer shipsets for Boeing 737 aircraft are defined and discussed. Author

## 11 CHEMISTRY AND MATERIALS

**N85-14882\*** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

### **FABRICATION AND QUALITY ASSURANCE PROCESSES FOR SUPERHYBRID COMPOSITE FAN BLADES**

R. F. LARK and C. C. CHAMIS 1983 15 p refs Presented at the 15th Ann. SAMPE Tech. Conf., Cincinnati, 4-5 Oct. 1983 (NASA-TM-83354; E-1611, NAS 1 15 83354) Avail. NTIS HC A02/MF A01 CSCL 11D

The feasibility of fabricating full-scale fan blades from superhybrid composites (SHC) for use large, commercial gas turbine engines was evaluated. The type of blade construction selected was a metal-spar/SHC-shell configuration, in which the outer shell was adhesively bonded to a short, internal, titanium spar. Various aspects of blade fabrication, inspection, and quality assurance procedures developed in the investigation are described. It is concluded that the SHC concept is feasible for the fabrication of prototype, full-scale, metal-spar/SHC-shell fan blades that have good structural properties and meet dimensional requirements.

R S F

**N85-14891** Department of the Army, Washington, D. C.

### **FINLET INJECTOR Patent**

D. B. HARMON, JR. and A. W. FOSS, inventors (to Army) 2 Sep 1980 4 p

(AD-D011245; US-PATENT-4,220,297, US-PATENT-APPL-SN-971459, US-PATENT-CLASS-244-3.21)

Avail. US Patent and Trademark Office CSCL 21B

A finlet injector for external burning fuel injection is provided to obtain a higher performance through a combination of more optimum air-to-fuel ratio and better air/fuel mixing. This is done by capturing (mixing with) a greater quantity of air for a given fuel injection pressure and flow rate. The device is thermally protected and, for most flight regimes, has minimum drag. Author (GRA)

**N85-14913#** National Aerospace Lab., Tokyo (Japan)

### **FRACTOGRAPHIC OBSERVATION AND ESTIMATION OF CRACK GROWTH CURVE OF ALUMINUM ALLOY UNDER RANDOM FLIGHT SIMULATION LOADING**

K. TSUCHIDA and K. IWASAKI Jul 1984 14 p refs In JAPANESE; ENGLISH summary

(NAL-TR-824; ISSN-0389-4010) Avail. NTIS HC A02/MF A01

Crack growth rates from fractographic observations of fracture surfaces subjected to two kinds of random flight simulation loading were examined. The crack growth curves were estimated under the assumption that the striation spacings correspond to the crack growth per flight. The assumption is concluded to be reasonable by the comparison of estimated and measured curves. Author

**N85-14943#** Catholic Univ. of America, Washington, D.C. Dept. of Chemistry.

### **STORAGE STABILITY OF JET FUELS Final Report, Feb. 1983 - Aug. 1984**

N. C. LI Aug 1984 45 p

(Contract N00014-83-K-2013)

(AD-A146360) Avail. NTIS HC A03/MF A01 CSCL 21D

Storage stabilities of jet fuels derived from petroleum were determined using laser light scattering, sediment formation, and oxygen uptake measurements. Fuel degradation was monitored in the presence of the following added specific compounds: 2,5-dimethylpyrrole (DMP), N-methyl pyrrole (NMP), thiophenol, thiophene, decanethiol, dibutyl sulfide, dibutyl disulfide, tetrahydrothiophene, hexadienes, 1-hexene, indene, and dimethyl quinoline (DMQ) and mixtures of these at various temperatures. The light scattering results are correlated with extent of deposit formation, which is an accepted measure of stability, and with oxygen uptake results. GRA

## 12

## ENGINEERING

Includes engineering (general), communications, electronics and electrical engineering, fluid mechanics and heat transfer; instrumentation and photography, lasers and masers, mechanical engineering, quality assurance and reliability; and structural mechanics

**A85-15999**

### **IMPROVED SURFACE PREPARATION OF AM355 FOR ADHESIVE BONDING**

A. G. HIRKO, J. E. SCHIBLER, and L. G. TAYLOR (Hughes Helicopters, Inc., Culver City, CA) IN Technology vectors, Proceedings of the Twenty-ninth National SAMPE Symposium and Exhibition, Reno, NV, April 3-5, 1984. Covina, CA, Society for the Advancement of Material and Process Engineering, 1984, p. 282-291.

Original processing of AM355 stainless steel for structural bonding consisted of a citric acid/alkaline permanganate method. This process showed indications of slight delaminations, with time, in field service testing of bonded assemblies. To reduce the possibility of delaminations it was decided to investigate an improved process. Alternate methods of surface preparation were reviewed and five common etch solutions were selected for further evaluation. The tests used in this study were of bonding and basic material characteristics. Bonding tests included T-peel, lap shear, and wedge crack propagations, material characteristic tests, of the chemically processed metal, included fatigue and hydrogen embrittlement. Of the solutions tested, the ferric chloride/hydrochloric acid etch gave the optimum combination of properties and has been chosen as the method of surface preparation to be used for structural bonding of AM355 in production. Author

**A85-16081**

### **ANTENNA ENGINEERING HANDBOOK /2ND EDITION/**

R. C. JOHNSON, ED. (Georgia Institute of Technology, Atlanta, GA) and H. JASIK, ED. (Eaton Corp., AIL Div., Deer Park, NY) New York, McGraw-Hill Book Company, 1984, 1356 p. No individual items are abstracted in this volume.

Essential principles, methods, and data for solving a wide range of problems in antenna design and application are presented. The basic concepts and fundamentals of antennas are reviewed, followed by a discussion of arrays of discrete elements. Then all primary types of antennas currently in use are considered, providing concise descriptions of operating principles, design methods, and performance data. Small antennas, microstrip antennas, frequency-scan antennas, conformal and low-profile arrays, adaptive antennas, and phased arrays are covered. The major applications of antennas and the design methods peculiar to those applications are discussed in detail. The employment of antennas to meet the requirements of today's complex electronic systems is emphasized, including earth station antennas, satellite antennas, seeker antennas, microwave-relay antennas, tracking antennas, radiometer antennas, and ECM and ESM antennas. Finally, significant topics related to antenna engineering, such as transmission lines and waveguides, radomes, microwave propagation, and impedance matching and broadbanding, are addressed. Author

A85-16087#

**TECHNICAL AND ECONOMICAL ASPECTS IN MANUFACTURING AVIATION AND SPACE COMPONENTS BY USING SUPERPLASTIC FORMING (SPF) AND/OR SUPERPLASTIC FORMING/DIFFUSION BONDING (SPF/DB)**

W BECK (Messerschmitt-Boelkow-Blohm GmbH, Bremen, West Germany) and P.-J WINKLER (Messerschmitt-Boelkow-Blohm GmbH, Ottobrunn, West Germany) Deutsche Gesellschaft fuer Metallkunde, Metallurgical Society of AIME, Akademia Nauk SSSR, et al, International Conference on Titanium, 5th, Munich, West Germany, Sept. 10-14, 1984, Paper 8 p refs (MBB-BB-572-84-OE)

The development of superplastic forming processes used in manufacturing aviation and space components, has been examined Superplastic forming (SPF) and superplastic forming/diffusion bonding (SPF/DB) are carried out on Ti6Al4V annealed sheet metals. The effect of different process parameters, such as tooling and hot removal, on the quality of different components, is discussed Process times can be reduced by hot charging, the use of a computer-aided process control system, and the use of ceramics Related development activities for SPF and SPF/DB components have focused on the selection of suitable components, component redesign to suit SPF processes, the definition of correct forming parameters and the final quality assurance M.D

A85-16095\*# National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio

**VIBRATION AND FLUTTER OF MISTUNED BLADED-DISK ASSEMBLIES**

K RAO, V KAZA (NASA, Lewis Research Center, Cleveland, OH), and R E KIELB AIAA, ASME, ASCE, and AHS, Structures, Structural Dynamics and Materials Conference, 25th, Palm Springs, CA, May 14-16, 1984 16 p Previously announced in STAR as N84-23923 refs (AIAA PAPER 84-0991)

An analytical model for investigating vibration and flutter of mistuned bladed disk assemblies is presented This model accounts for elastic, inertial and aerodynamic coupling between bending and torsional motions of each individual blade, elastic and inertial couplings between the blades and the disk, and aerodynamic coupling among the blades The disk was modeled as a circular plate with constant thickness and each blade was represented by a twisted, slender, straight, nonuniform, elastic beam with a symmetric cross section The elastic axis, inertia axis, and the tension axis were taken to be noncoincident and the structural warping of the section was explicitly considered The blade aerodynamic loading in the subsonic and supersonic flow regimes was obtained from two-dimensional unsteady, cascade theories All the possible standing wave modes of the disk and traveling wave modes of the blades were included The equations of motion were derived by using the energy method in conjunction with the assumed mode shapes for the disk and the blades Continuities of displacement and slope at the blade-disk junction were maintained The equations were solved to investigate the effects of blade-disk coupling and blade frequency mistuning on vibration and flutter Results showed that the flexibility of practical disks such as those used for current generation turbomachines did not have a significant influence on either the tuned or mistuned flutter characteristics However, the disk flexibility may have a strong influence on some of the system frequencies and on forced response Author

A85-16112

**FATIGUE STRENGTH OF ALUMINIZED BOLTED JOINTS [SCHWINGFESTIGKEIT ALUMINIERTER BOLZENVERBINDUNGEN]**

K HOFFER (Vereinigte Flugtechnische Werke GmbH, Bremen, West Germany) Aluminium (ISSN 0002-6689), vol 60, no 2, 1984, p 113-115 In German refs (MBB-VFW-53-84-OE)

The results of comparative fatigue-strength tests on joints bolted with steel bolts coated chemically with Cd or mechanically with Al are presented in tables and graphs Coated M6 and M12 bolts

with standard nuts are tested in 20 and 60-kN vertical-pulse apparatus, respectively, after prestressing to 70 percent of the yield stress and with or without exposure to a 3.5-percent NaCl solution for 600 h (10 min submerged followed by 50 min air drying) under stress conditions typical of aircraft construction It is found that the Al-coated bolts have fatigue-strength and corrosion-resistance properties very similar to those of Cd-coated bolts, suggesting that Al is an adequate substitute for the environmental pollutant Cd as a corrosion-protection layer for steel components T K

A85-16232#

**REVIEW OF BLIND RIVETS AND BLIND-RIVETING TECHNIQUES. I [PRZEGLAD NITOW I TECHNIK ZAKUWANIA NITOW Z DOSTEPEM JEDNOSTRONNYM. I]**

Z MIZERA (WSK PZL, Mielec, Poland) Technika Lotnicza i Astronautyczna (ISSN 0040-1145), vol 39, July 1984, p 22-26 In Polish

Blind rivets for high-strength riveted joints are considered Particular attention is given to a review of rivets of this type being manufactured, including rivet characteristics, the principle of operation, and relevant standards L M

A85-16233#

**REVIEW OF BLIND RIVETS AND BLIND-RIVETING TECHNIQUES. II [PRZEGLAD NITOW I TECHNIK ZAKUWANIA NITOW Z DOSTEPEM JEDNOSTRONNYM. II]**

Z MIZERA (Panstwowe Zaklady Lotnicze, Mielec, Poland) Technika Lotnicza i Astronautyczna (ISSN 0040-1145), vol 39, Aug 1984, p 26-28 In Polish refs

A85-16242#

**OPTIMIZING THE USE OF SURFACE SENSORS FOR WIND SHEAR DETECTION**

A J BEDARD, JR. (NOAA, Wave Propagation Laboratory, Boulder, CO) Journal of Aircraft (ISSN 0021-8669), vol 21, Dec 1984, p 971-977 Previously cited in issue 08, p 1085, Accession no A84-21866 refs

A85-16243\*# National Aeronautics and Space Administration Langley Research Center, Hampton, Va.

**TURBULENT ROUGHNESS DRAG DUE TO SURFACE WAVINESS AT LOW ROUGHNESS REYNOLDS NUMBERS**

J C LIN and M J WALSH (NASA, Langley Research Center, High-Speed Aerodynamics Div., Hampton, VA) Journal of Aircraft (ISSN 0021-8669), vol 21, Dec 1984, p 978, 979. refs

The current investigation has the objective to provide data which will make it possible to obtain a better estimate regarding the roughness drag for surface waviness The data employed for this investigation were acquired in connection with a wavy wall study which was conducted as part of an overall program to reduce the skin friction of turbulent boundary layers in external flows The results of the present investigation show that the low-speed roughness drag of small-amplitude sinusoidal wave trains having wavelengths of the order of the boundary-layer thickness is not only a function of  $h/\lambda$  ( $h$  = total wave height,  $\lambda$  = wavelength), but, in addition, is also a function of the roughness Reynolds number G R

A85-16251

**STRUCTURAL FAILURE, PRODUCT LIABILITY AND TECHNICAL INSURANCE; PROCEEDINGS OF THE FIRST INTERNATIONAL CONFERENCE, TECHNISCHE UNIVERSITAET WIEN, VIENNA, AUSTRIA, SEPTEMBER 26-29, 1983**

H P ROSSMANITH, ED (Wien, Technische Universitaet, Vienna, Austria) Amsterdam, North-Holland, 1984, 338 p For individual items see A85-16252 to A85-16256

Various papers on structural failure, product liability, and technical insurance are presented A few of the topics discussed include failure analysis of aircraft parts, examples of failure analyses in metal structures, application of a quality assurance system in the production of materials and components, finite

elements in fracture mechanics, and the effect of sonic boom on a cracked plaster-wood wall C.D

**A85-16252**

**FAILURE ANALYSIS OF AIRCRAFT PARTS**

G. A. LANGE (Braunschweig, Technische Universitaet, Brunswick, West Germany) IN Structural failure, product liability and technical insurance, Proceedings of the First International Conference, Vienna, Austria, September 26-29, 1983 Amsterdam, North-Holland, 1984, p. 93-98 refs

The statistics and initiation of civil-aircraft parts failure due to fatigue, overload, and corrosion are studied on 165 failures of various parts of airplanes, helicopters, and gliders. The failures due to technical deficiencies account for 9 percent of all accidents, 57 percent were due to fatigue failures, 37 percent were due to overload, and 4 percent were due to corrosion. Among the parts examined are helicopter rotor blades, impellers, connecting rods and crankshafts. Design deficiencies are shown to have caused 34 of 94 fatigue failures, while the overload failures were mainly caused by external overload or were results of the accident. The parts examined were made of steel (70 percent), wrought or cast aluminum alloys (24 percent), magnesium alloys, Inconel, brass, and sintered or cast iron. L.T

**A85-16253**

**TWO EXAMPLES OF FAILURE-ANALYSES IN METAL STRUCTURES**

K. L. MAURER (Leoben, Montanuniversitaet, Leoben, Austria) IN Structural failure, product liability and technical insurance; Proceedings of the First International Conference, Vienna, Austria, September 26-29, 1983 Amsterdam, North-Holland, 1984, p. 99-106

Two different cases of damage are described and analysed. In this paper the first example shows the breakages of coupling hooks of irrigation pipes. The reason of failure was found to be first of all the application of an unsuitable material, which tends to strain aging. Further intensification towards breakage lies in the construction not avoiding sharp notches. The second example shows the neglect of essential principles of design in aircraft construction. Cracks appeared in a part of the shock absorber attachment of the main undercarriage of aircraft. The result of investigation indicated that the cracks are caused by a stiff design of the flange sheet. The crack will be stopped after a certain crack extension. The increase of the compliance caused reduction of stress intensity. Author

**A85-16266**

**THE DIFFRACTION OF SOUND WAVES BY AN ELASTIC HALF-PLANE ATTACHED TO A VERTICAL RIGID PLANE**

F. GHANDCHI (Dundee, University, Dundee, Scotland) Quarterly Journal of Mechanics and Applied Mathematics (ISSN 0033-5614), vol. 37, Nov. 1984, p. 553-563. refs

The sound field of a line source is investigated when a structure consisting of a semi-infinite thin elastic plate, attached at right angles to a rigid plate of infinite extent, is embedded in a stationary acoustic medium. A formal exact solution is presented and the distant sound field is explicitly derived, with emphasis on the free modes of the coupled fluid-structure system. The significance of the contributions associated with different parts of the structure is exposed by taking two distinct limits of the fluid loading parameter relevant in aerodynamic and underwater problems. Author

**A85-16286**

**A FINITE ELEMENT PENALTY ALGORITHM FOR THE PARABOLIC NAVIER-STOKES EQUATIONS FOR TURBULENT THREE-DIMENSIONAL FLOW**

A. J. BAKER (Tennessee, University, Knoxville, TN) Computer Methods in Applied Mechanics and Engineering (ISSN 0045-7825), vol. 46, Nov. 1984, p. 277-293 refs

The three-dimensional Navier-Stokes equations governing steady, turbulent subsonic flows have been simplified into the 'parabolic' form using a formal order of magnitude analysis procedure. The results of this analysis confirm that the transverse

momentum equations, to first order, govern appropriate pressure distributions, and that the continuity equation governs first-order effects of transverse plane momenta. This paper reviews the identification of a well-posed, initial-boundary-value differential equation description, and construction and evaluation of a numerical solution algorithm for the parabolic Navier-Stokes equations in physical variables. Numerical results for a broad problem class range in fluid mechanics are summarized, highlighting the versatility and accuracy of the algorithm. Author

**A85-16650**

**AN APPROACH TO AUTOMATIC FLIR VIDEO ASSESSMENT**

M. J. BOYD (U.S. Naval Weapons Center, China Lake, CA) and A. G. SUTTON (Comarco, Inc., Simutech Div., Ridgecrest, CA) (Institute of Electrical and Electronics Engineers, Autotestcon '83, Fort Worth, TX, Nov. 1-3, 1983) IEEE Transactions on Instrumentation and Measurement (ISSN 0018-9456), vol. IM-33, Dec. 1984, p. 322-327

This paper describes an approach to automatic video assessment of military infrared imaging systems by employing automated analysis techniques on measured system responses. Included are a description of the developmental test configuration and methodology, and a description of the activity with initial findings and conclusions. Author

**A85-16763**

**FREE VIBRATION CHARACTERISTICS OF PERIODICALLY STIFFENED PANELS WITH DAMPED STRINGERS**

S. NARAYANAN, B. V. R. GUPTA, and N. GANESAN (Indian Institute of Technology, Madras, India) Journal of Sound and Vibration (ISSN 0022-460X), vol. 96, Sept. 8, 1984, p. 55-68 refs

Free vibration characteristics of a periodically stiffened panel with unconstrained viscoelastic damping layers applied to the flanges of the stringers are analyzed by using the wave propagation approach. Periodic structure theory in conjunction with the concept of damped forced waves is used in the determination of resonant frequencies and the associated loss factors of the composite structure. The complex nature of the rotational and transverse stiffness of the stringers is taken into consideration in the analysis. Numerical results showing the effect of the geometric and material properties of the damping layer treatment on the resonant frequencies and loss factors of the composite panel are presented. Author

**A85-16915**

**AN ENGINEERING METHOD FOR EVALUATING UNSTEADY AERODYNAMIC EFFECTS ON CASCADE BLADES DURING FLEXURAL VIBRATIONS [INZHENERNYI METOD OTSENKI NESTATSIONARNYKH AERODINAMICHESKIKH VOZDEISTVII NA LOPATKI RESHETKI PRI IKH IZGIBNYKH KOLEBANIYAKH]** V. A. BALALAEV, A. A. KAMINER, and A. L. STELMAKH (Akademiia Nauk Ukrainskoi SSR, Institut Problem Prochnosti, Kiev, Ukrainian SSR) Problemy Prochnosti (ISSN 0556-171X), Nov. 1984, p. 104-107. In Russian. refs

An empirical formula is derived which relates the aerodynamic logarithmic decrement of the flexural vibrations of a blade in a cascade to the angle of attack, Strouhal number, cascade pitch, and vibration phase shift between adjacent blades. The formula is based on the assumption that disturbance pressures induced by the profiles of a vibrating cascade are attenuated along the cascade front in accordance with an exponential law. Calculations based on the formula proposed here are in good agreement with experimental data in the operating parameter range typical for turbines. V.L.

**A85-17053****THE FLANGE ELEVATION ANGLE DURING THE DRAWING OF AXISYMMETRIC PARTS [UGOL POD'EMA FLANTSА PRI VYTIASHKE OSESIMMETRICHNYKH DETALEI]**

N. M. BIRIUKOV and I. U. UVAROV. *Aviatsionnaya Tekhnika* (ISSN 0579-2975), no. 2, 1984, p. 12-16. In Russian.

During the drawing of parts with free (unclamped) flanges, the flange rises and assumes a funnel shape, with both tensile and compressive stresses generated in the flange. Here, the stress-strain state of the flange is analyzed, and an energy equilibrium equation is derived which makes it possible to determine the elevation angle of the flange during drawing. The results obtained are compared with data in the literature. V. L.

**A85-17056****DETERMINATION OF STRESSES IN ELASTIC AIRCRAFT SURFACES DURING MOTION IN UNSTEADY FLOW [OPREDELENIE NAPRIAZHENII V UPYUGIKH AVIATSIONNYKH POVERKHNOSTIYKH PRI DVIZHENII V NESTATSIONARNOM POTOKE]**

M. B. VAKHITOV, A. S. SAFONOV, and I. A. KUZNETSOV. *Aviatsionnaya Tekhnika* (ISSN 0579-2975), no. 2, 1984, p. 26-29. In Russian. refs.

On the basis of a discrete-continuum model, a numerical procedure is developed for determining stresses and strains in thin-walled aircraft structures of the wing-tail type under time-variable loading. The aerodynamic load is determined using the discrete vortex method. The numerical procedure involves the use of integrating matrices and finite differences. As an example, a calculation is made of the dynamic response of a wing to a discrete gust. V. L.

**A85-17057****STABILITY OF THE SHELL STRUCTURES OF POWERPLANTS WITH VARIABLE STIFFNESS PARAMETERS [USTOICHIVOST' OBOLOCHICHNYKH KONSTRUKTSII DVIGATEL'NYKH USTANOVOK S PEREMENNymi PARAMETRAMI ZHESTKOSTI]**

A. M. GIRIN. *Aviatsionnaya Tekhnika* (ISSN 0579-2975), no. 2, 1984, p. 30-34. In Russian.

A method is proposed for the stability analysis of shell-type powerplant components with variable stiffness parameters under conditions of complex loading. Stability conditions are obtained in the form of differential and integral equations. Computational formulas are presented for cantilever shells. V. L.

**A85-17063****OPTIMAL PROBABILISTIC DESIGN OF THE STRUCTURES OF FLIGHT VEHICLES [OPTIMAL'NOE VEROIATNOSTNOE PROEKTIROVANIE KONSTRUKTSII LETATEL'NYKH APPARATOV]**

V. I. PERLIK, V. P. SAVCHUK, and G. G. KHARITONOVA. *Aviatsionnaya Tekhnika* (ISSN 0579-2975), no. 2, 1984, p. 59-63. In Russian. refs.

A general approach to the optimal probabilistic design of flight vehicle structures is formulated in terms of mathematical programming using performance models. An attempt is thus made to combine design and reliability objectives by using reliability models that are adequately coupled with methods of structural design. The approach proposed here is illustrated by an example, and comparison is made with the traditional deterministic approach. V. L.

**A85-17070****STRENGTH ANALYSIS OF AIRCRAFT STRUCTURES USING A MIXED SUPERELEMENT METHOD [RASHCHET NA PROCHNOST' AVIATSIONNYKH KONSTRUKTSII SMESHANNYM SUPERELEMENTNYM METODOM]**

Z. I. BURMAN and G. A. DESIATNIK. *Aviatsionnaya Tekhnika* (ISSN 0579-2975), no. 2, 1984, p. 89-91. In Russian.

A version of the superelement method is presented in which individual substructures are analyzed using different finite element models (i.e., the force method, the displacement method, and the hybrid method), and the resulting superelements are then combined

into a whole. This approach, referred to as the mixed superelement method, makes it possible to efficiently calculate irregular structures and select an optimum model for each section. The method has been implemented in a set of application software for the analysis of aircraft structures. An example involving the tail section of a helicopter is presented. V. L.

**A85-17071****STRENGTH ANALYSIS OF AIRCRAFT STRUCTURES BY THE STEP METHOD UNDER CONDITIONS OF PHYSICAL NONLINEARITY [K VOPROSU RASCHETA NA PROCHNOST' AVIATSIONNYKH KONSTRUKTSII SHAGOVYM METODOM V USLOVIAKH FIZICHESKOI Nelineinosti]**

I. U. A. DENISOV and I. U. G. POPOV. *Aviatsionnaya Tekhnika* (ISSN 0579-2975), no. 2, 1984, p. 91-93. In Russian. refs.

The solution of nonlinear elasticity and plasticity problems using the method of successive approximations involves determining the Frechet potential of the nonlinear operator  $T(u, p) = 0$ , where  $u = u(x)$  is the vector of the unknowns,  $p = p(x, t)$  is a load parameter, and  $x = (x_1, x_2, x_3)$  represents the coordinates of the individual points of a body. Here, this problem is solved using a version of the step method in which the operator is treated directly as a piecewise linear operator, rather than a smooth one. This approach provides an accurate description of the entire deformation history of all the load-bearing elements of a structure under complex loading. V. L.

**A85-17169#****THE TREATMENT OF RIGID-SUBSTRUCTURES IN MODAL SYNTHESIS METHODS**

D. ZHANG, G. LIU, and J. LI. *Chinese Society of Astronautics, Journal*, July 1984, p. 39-49. In Chinese, with abstract in English. refs.

This paper discusses the necessity of developing a method of treating rigid-substructures by modal synthesis techniques, and gives a very simple and convenient method for treating rigid-substructures in 'fixed interface methods' and 'pseudo-fixed interface methods'. This paper also demonstrates that the method is correct. It simply describes how the present method applies to traditional 'free-interface methods'. Author.

**A85-17173#****AN ANALYSIS OF THE PATTERN OF LONGITUDINAL SLOT ANTENNA ON THE METAL CYLINDER COVERED WITH A HIGH COLLISION PLASMA LAYER**

N. DONG and S. XIA. *Chinese Society of Astronautics, Journal*, July 1984, p. 76-84. In Chinese, with abstract in English. refs.

In this paper, the pattern of a longitudinal slot antenna on a metal cylinder covered with a loss plasma layer (high collision layer) is discussed. Based on Maxwell's equation, the cylindrical coordinate systems solution of the radiation field is derived, and the use of the bound value of a metal cylinder is considered. Some of the numerical results obtained in this paper approximated the experimental results. Author.

**A85-17839#****APPLICATION OF DIGITAL SIGNAL PROCESSING TO A LOW DATA RATE COMMUNICATIONS RECEIVER**

R. G. HENDERSON and P. LAFRANCE (Mitre Corp., Naval Systems Engineering Div., McLean, VA). *IN Digital Avionics Systems Conference*, 6th, Baltimore, MD, December 3-6, 1984, Proceedings. New York, American Institute of Aeronautics and Astronautics, 1984, p. 252-256. refs. (AIAA PAPER 84-2652).

This paper explores the application of digital signal processing techniques to replace and even improve receiver functions which are conventionally performed by analog circuitry. All signals downstream of the last IF stage are processed digitally. The IF processing system under consideration consists of several components. A pre-processor samples the 22 kilohertz wide IF. The resulting sequence is then digitally Hilbert transformed to produce the in-phase and quadrature components of an analytic signal. Several cascaded stages of filtering and decimation follow.

to produce a baseband signal with a bandwidth of 7 kilohertz and within which the information is known to reside, but with an a priori unknown doppler shift. The second stage of the system accomplishes further bandwidth compression by processing a spectral representation of the signal via a real time Fourier transform followed by decision logic. Performance is analyzed and design issues are discussed  
Author

### A85-17880#

#### **GATE ARRAY, STANDARD CELL, AND FULLY CUSTOM - BUILDING BLOCKS FOR THE DIGITAL AVIONICS DESIGNER**

H. L. OWEN, III and M. T. KOPP (Georgia Institute of Technology, Atlanta, GA) IN: Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings. New York, American Institute of Aeronautics and Astronautics, 1984, p 517-522

(AIAA PAPER 84-2711)

The VLSI design options called Gate Array, Standard Cell, and Fully Custom are studied along with digital hybrids and programmable logic. The design process for each of the options is illustrated and design methodologies are outlined. Design considerations required in order to use CAD tools in the design process are examined along with testability and packaging considerations  
C D

### A85-17887#

#### **VLSI CHIP SET FOR HIGH-PERFORMANCE AVIONIC COMPUTERS**

S. J. FORDE and M. A. HILMANTEL (Sanders Associates, Computer Engineering Dept., Nashua, NH) IN: Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings. New York, American Institute of Aeronautics and Astronautics, 1984, p 569-572.

(Contract N00014-84-C-2250)

(AIAA PAPER 84-2730)

It is pointed out that today's avionics computers must combine high processing throughput with low power consumption and small size, and yet remain cost-effective and flexible. As the result of new technological developments, the considered requirements can be satisfied with the aid of a VLSI chip set. This chip set consists of four chips, including the microsequencer (USEQ), the arithmetic and logic unit (ALU), the operand generator unit (OGU), and the memory controller unit (MCU). The four chips can be configured (with appropriate support chips) to implement the Air Force standard instruction set architecture (ISA), MIL-STD-1750 A. The same chips can also be used to emulate the Navy standard 16-bit computers AN/UYSK-20, AN/AYK-14, and AN/UYK-44  
G R

### A85-17896#

#### **COMMON MODULAR AVIONICS - PARTITIONING AND DESIGN PHILOSOPHY**

D. M. SCOTT and S. P. MULVANEY (General Dynamics Corp., Fort Worth, TX) IN: Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings. New York, American Institute of Aeronautics and Astronautics, 1984, p. 624-628.

(AIAA PAPER 84-2745)

The design objectives and definition criteria for common modular hardware that will perform digital processing functions in multiple avionic subsystems are examined. In particular, attention is given to weapon system-level objectives, such as increased supportability, reduced life cycle costs, and increased upgradability. These objectives dictate the following overall modular design goals: reduce test equipment requirements; have a large number of subsystem applications; design for architectural growth, and standardize for technology transparent implementations. Finally, specific partitioning criteria are derived on the basis of the weapon system-level objectives and overall design goals  
V L

### A85-17897#

#### **MODULAR STANDARDS FOR EMERGING AVIONICS TECHNOLOGIES**

B. RADCLIFFE (ARINC Research Corp., Annapolis, MD) and J. BOAZ (USAF, Avionics Laboratory, Wright-Patterson AFB, OH) IN: Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings. New York, American Institute of Aeronautics and Astronautics, 1984, p 629-633

(AIAA PAPER 84-2747)

The present investigation is concerned with modular standards for the integration of new avionics technologies into production aircraft, taking into account also major retrofit programs. It is pointed out that avionics systems are about to undergo drastic changes in the partitioning of functions and judicious sharing of resources. These changes have the potential to significantly improve reliability and maintainability, and to reduce costs. Attention is given to a definition of the modular avionics concept, the existing module program, the development approach, development progress on the modular avionics standard, and the future of avionics installation standards.  
G R

### A85-17898#

#### **HIGH DENSITY MODULAR AVIONICS PACKAGING**

F. PORADISH (Texas Instruments, Inc., Dallas, TX) IN: Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings. New York, American Institute of Aeronautics and Astronautics, 1984, p 634-640.

(AIAA PAPER 84-2749)

Requirements and design configurations for high density modular avionics packaging are examined, with particular attention given to new hardware trends, the design of high-density standard modules (HDSM's), and HDSM requirements. The discussion of the HDSM's covers thermal management, system testability, power supply, and performance specifications. The general design of an integrated HDSM demonstration system currently under construction is briefly described, and some test data are presented  
V L

### A85-17899#

#### **MODULAR AVIONICS PACKAGING STANDARDIZATION**

M. AUSTIN and J. K. MCNICHOLS (U.S. Navy, Naval Avionics Center, Indianapolis, IN) IN: Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings. New York, American Institute of Aeronautics and Astronautics, 1984, p 641-645

(AIAA PAPER 84-2746)

The Modular Avionics Packaging (MAP) Program for packaging future military avionics systems with the objective of improving reliability, maintainability, and supportability, and reducing equipment life cycle costs is addressed. The basic MAP packaging concepts called the Standard Avionics Module, the Standard Enclosure, and the Integrated Rack are summarized, and the benefits of modular avionics packaging, including low risk design, technology independence with common functions, improved maintainability and life cycle costs are discussed. Progress made in MAP is briefly reviewed  
C D

### A85-18340#

#### **DYNAMIC ANALYSIS OF LARGE-SCALE MECHANICAL SYSTEMS AND ANIMATED GRAPHICS**

P. E. NIKRAVESH (Iowa, University, Iowa City, IA) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol 8, Jan.-Feb 1984, p 104-109 refs

(AIAA PAPER 83-0946)

This paper presents a computer-based method for formulation and solution of coupled differential and algebraic equations describing large-scale mechanical systems, including feedback control, aerodynamic forces, and other multidisciplinary effects that interact with the mechanical system. A Euler parameter representation of the configuration of the mechanical system is employed to obtain singularity free solution for generalized coordinates and a much simplified algebraic formulation of the governing system of equations, compared with the more classical

Euler angle generalized coordinate formulation. A generalized coordinate partitioning algorithm is employed to identify independent generalized coordinates automatically and reduce the dimension of the numerical integration problem. Animated graphics output is employed to assist in visualization of dynamic performance of several systems - a parachute descending in air, an aircraft landing on a damaged runway, and a truck with flexible chassis

Author

#### A85-18439#

##### **CAD/CAM INTEGRATION - THE IMPERATIVES**

R H JACKSON (Rockwell International Corp., Tulsa, OK) Aerospace America (ISSN 0740-722X), vol. 23, Jan 1985, p. 102, 103.

The assimilation of CAD/CAM capabilities into the organizational/production aspects of a manufacturing company are discussed. One company has begun the process by automating the engineering department, with all final design products subject to one vice-president's approval before being sent to the production line, which will eventually become an integrated part of the automated process. Another firm has established a CAE team within the engineering department to refine preliminary work and recommendations from other sources and fit them into manufacturing specifications. It is recommended that all managers and users be familiarized with CAD/CAM systems and that all defect-tendencies induced into people working under production pressure be anticipated and eliminated. It is emphasized that incorporating CAD/CAM into a company is as much a matter of the people involved as the technical considerations.

M.S.K.

#### A85-18440#

##### **MILITARY ELECTRONICS - WHY SO UNRELIABLE?**

E J LERNER Aerospace America (ISSN 0740-722X), vol. 23, Jan 1985, p. 106-109.

The causes and remedies for unreliable electronics components procured by the DOD are examined. It is noted that the procurement agencies have in the recent past failed to specify the required lifetimes, have sacrificed reliability to lower costs, meet schedules or reach performance goals, and have not monitored the programs. The burden of reliability is to be left to reliability engineers, who have to review the works of designers before parts are manufactured for testing. Oversight is necessary to assure that all parts of an assembly actually meet mil-specs and are not commercial analogs or untested materials. A different problem exists for aluminum in circuit components, which may experience electromigration during burn-in. It is recommended that manufacturers be required to answer questions of reliability assurance before bidding begins, rather than after awards of contracts.

M.S.K.

#### A85-18466#

##### **VERY-SHORT-PULSE MODULATOR USING ASYMMETRIC THYRISTORS [MODULATEUR A IMPULSIONS TRES COURTES UTILISANT DES THYRISTORS ASYMETRIQUES]**

P PEROL (Thomson-CSF, Centre Electronique de Brest, Brest, France) Revue Technique Thomson-CSF (ISSN 0035-4279), vol. 16, Sept. 1984, p. 493-501. In French.

The development of a semiconductor delay-line modulator for a 40-nsec/pulse 10-kHz-repetition-rate coaxial magnetron radar used to monitor airport runway traffic is reported and illustrated with circuit diagrams, output spectra, and photographs. The problems presented by the design specifications are indicated, and the solutions adopted (asymmetric press-packed thyristors and ferrite pulse transformer) are explained. Pulse widths and peak powers with 16 nF of delay line and a 2.5-kV charge at the level of the modulator are found to be 120 nsec and 58 kW without truncation and 40 nsec and 50-51 kW with truncation, the latter corresponding to an efficiency of 17 percent. The pulse leading edges have  $dI/dt$  at the transformer primary = 1.8 kA/microsec and  $dV/dt$  at the magnetron = 160 kV/microsec.

T.K.

#### A85-18531#

##### **AN ANALYSIS OF UNSTEADY TORQUE ON A QUASI-THREE-DIMENSIONAL CENTRIFUGAL IMPELLER**

Y TSUJIMOTO, K IMAICHI (Osaka University, Toyonaka, Japan), T TOMOHIRO (Matsushita Housing Products, Yamato-koryama, Nara, Japan), and M GOTOO (Ebara Corp., Research Laboratory, Fujisawa, Kanagawa, Japan) JSME, Bulletin (ISSN 0021-3764), vol. 27, Oct 1984, p. 2166-2172. refs

The effects of a change in the breadth of a centrifugal impeller on unsteady torque are determined on the assumption of a quasi-three-dimensional flow. Small sinusoidal fluctuations of rotational velocity and/or flow rate are considered. The unsteady torque is divided into three components: quasi-steady, apparent mass, and wake. Numerical results show that the wake component is usually smaller than the other components. Apparent mass coefficients for the two disturbances are given for quasi-three-dimensional impellers. It is found that the outer-to-inner breadth ratio has little effect on the apparent mass coefficient for flow-rate fluctuation, but the coefficient for rotational fluctuation is larger for impellers with smaller outer-to-inner breadth ratios.

Author

A85-18684\*# National Aeronautics and Space Administration Langley Research Center, Hampton, Va.

##### **SPECTRAL METHODS FOR THE EULER EQUATIONS. I - FOURIER METHODS AND SHOCK CAPTURING**

M. Y. HUSSAINI, D. A. KOPRIVA, M. D. SALAS, and T. A. ZANG (NASA, Langley Research Center, Hampton, VA) AIAA Journal (ISSN 0001-1452), vol. 23, Jan 1985, p. 64-70. refs (Contract NAS1-17070, NAS1-17130)

Spectral methods for compressible flows are introduced in relation to finite difference and finite element techniques within the framework of the method of weighted residuals. Current spectral collocation methods are put into historical context. The basic concepts of Fourier spectral collocation methods are provided. Filtering strategies for shock-capturing approaches are also presented. Fourier shock-capturing techniques are evaluated using a one-dimensional, periodic astrophysical 'nozzle' problem.

Author

A85-18693\*# Sandia Labs., Albuquerque, N. Mex.

##### **STRUCTURAL OPTIMIZATION WITH DYNAMIC BEHAVIOR CONSTRAINTS**

W. C. MILLS-CURRAN (Sandia National Laboratory, Albuquerque, NM) and L. A. SCHMIT (California, University, Los Angeles, CA) (Structures, Structural Dynamics and Materials Conference, 24th, Lake Tahoe, NV, May 2-4, 1983, Collection of Technical Papers, Part 1, p. 369-382) AIAA Journal (ISSN 0001-1452), vol. 23, Jan 1985, p. 132-138. Previously cited in issue 12, p. 1739, Accession no. A83-29766. refs (Contract NSG-1490)

#### A85-18724

##### **AERONAUTICAL TUBES AND PIPES (TUBES ET TUYAUTERIES AERONAUTIQUES)**

N. BEAUCLAIR Air et Cosmos (ISSN 0044-6971), vol. 22, Dec. 15, 1984, p. 29, 31-36. In French.

The main and subcomponent French suppliers of aircraft tubes and pipes are discussed, and the state of the industry is analyzed. Quality control is essential for tubes with regard to their i.d. and metallurgical compositions. French regulations do not allow welded seam tubes in hydraulic circuits unless no other form is available, and then rustproofed steel must be installed. The actual low level of orders for any run of tubes dictates that the product is only one of several among the manufacturers' line. Automation, both in NDT and quality control, assures that the tubes meet specifications. A total of 10 French companies participate in the industry, serving both civil and military needs, with some companies specializing only in titanium, steel, or aluminum materials. Concerns wishing to enter the market must upgrade their equipment to meet the higher aeronautical specifications and be prepared to furnish tubes and pipes that serve both functional and structural purposes simultaneously. Additionally, pipe-bending machines must also



perform to tight specifications Pipes can range from 0.2 mm exterior diameter to 40 mm, with wall thicknesses from 0.02 mm to 3 mm. A chart containing a list of manufacturers and their respective specifications and characteristics is presented, and a downtrend in production with reduction of personnel is noted

M.S.K

**A85-18810****ALGORITHMIC MASS-FACTORING OF FINITE ELEMENT MODEL ANALYSES AN UPDATE: GRID-DENSITY SENSITIVITY**

P. J. PINCHA (Boeing Military Airplane Co., Seattle, WA) Society of Allied Weight Engineers, Annual Conference, 42nd, Anaheim, CA, May 23-25, 1983. 18 p.  
(SAWE PAPER 1524)

The effect the grid density used in a finite element model (FEM) has on the final structural mass estimation accuracy is analyzed. A delta wing configuration with known physical characteristics is used for the study, which is carried out with the ISAS/SAMECS structural optimization and analysis program with weight determined by algorithmic mass factoring (AM/FM). Grid densities of 439, 767, and 1737 elements are employed. Account is taken of the spars, ribs, stiffeners, skin, and deflections under a 1000 lb load. Comparisons are made between results obtained by modeling the stiffeners as rod or beam elements or as slumped stiffeners. The AM/FM method provides acceptable accuracy with either type of stiffener variant or grid density

M.S.K

**A85-18816****COST REDUCTION ADVANTAGES OF CAD/CAM**

G. T. PARSONS (General Dynamics Corp., Convair Div., San Diego, CA) Society of Allied Weight Engineers, Annual Conference, 42nd, Anaheim, CA, May 23-25, 1983. 10 p. refs  
(SAWE PAPER 1549)

Features of the CAD/CAM system implemented at the General Dynamics Convair division are summarized. CAD/CAM was initiated in 1976 to enhance engineering, manufacturing and quality assurance and thereby the company's competitive bidding position. Numerical models are substituted for hardware models wherever possible and numerical criteria are defined in design for guiding computer-controlled parts manufacturing machines. The system comprises multiple terminals, a data base, digitizer, printers, disk and tape drives, and graphics displays. The applications include the design and manufacture of parts and components for avionics, structures, scientific investigations, and aircraft structural components. Interfaces with other computers allow structural analyses by finite element codes. Although time savings have not been gained compared to manual drafting, components of greater complexity than could have been designed by hand have been designed and manufactured

M.S.K

**A85-18827\*#** Stanford Univ., Calif.**HEAT TRANSFER EFFECTS OF LONGITUDINAL VORTICES EMBEDDED IN A TURBULENT BOUNDARY LAYER**

P. A. EIBECK and J. K. EATON (Stanford University, Stanford, CA) American Society of Mechanical Engineers, National Heat Transfer Conference, Niagara Falls, NY, Aug 5-8, 1984. 7 p. Research supported by the U.S. Department of Energy and NASA refs  
(ASME PAPER 84-HT-21)

The results of tests with five different vortex generators in an open circuit wind tunnel are reported. The tests were performed to enhance the data base on heat transfer effects of an isolated longitudinal vortex in a turbulent boundary layer and the effects of embedded vortex pairs. A heated plate was set in the boundary layer downstream of a tripping mechanism and measurements were made of the free stream and surface temperatures using thermocouples. A four-hole cobra probe assayed the velocity profiles. Trials revealed that vortex pairs with scales larger than the boundary layer thickness induce significant changes in the Stanton number. A 15 percent Stanton number increase was produced by isolated vortices, which swept cool free stream fluid into the near-wall region

M.S.K

**N85-14116\*#** National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio

**ROTORDYNAMIC INSTABILITY PROBLEMS IN HIGH-PERFORMANCE TURBOMACHINERY**

Washington Dec 1984. 507 p. refs. Workshop held in College Station, Tex., 28-30 May 1984; sponsored by Texas A&M Univ., Army Research Office, and the Air Force Aeropropulsion Lab.

(NASA-CP-2338; E-2214; NAS 1.55:2338) Avail: NTIS HC A22/MF A01 CSCL 131

Rotordynamics and predictions on the stability of characteristics of high performance turbomachinery were discussed. Resolutions of problems on experimental validation of the forces that influence rotordynamics were emphasized. The programs to predict or measure forces and force coefficients in high-performance turbomachinery are illustrated. Data to design new machines with enhanced stability characteristics or upgrading existing machines are presented.

**N85-14117\*#** Exxon Research and Engineering Co., Florham Park, N.J.

**FULL LOAD TESTING IN THE PLATFORM MODULE PRIOR TO TOW-OUT: A CASE HISTORY OF SUBSYNCHRONOUS INSTABILITY**

J. W. FULTON. In NASA Lewis Research Center Rotordynamic Instability Problems in High-Performance Turbomachinery p 1-16 Dec 1984 refs

Avail: NTIS HC A22/MF A01 CSCL 131

An electric motor driven centrifugal compressor to supply gas for further compression and reinjection on a petroleum production platform in the North Sea was examined. The compressor design, raised concerns about susceptibility to subsynchronous instability. Log decrement, aerodynamic features, and the experience of other compressors with similar ratios of operating to critical speed ratio versus gas density led to the decision to full load test. Mixed hydrocarbon gas was chosen for the test to meet discharge temperature restrictions. The module was used as the test site. Subsynchronous vibrations made the compressor inoperable above approximately one-half the rated discharge pressure of 14500 kPa. Modifications, which include shortening the bearing span, change of leakage inlet flow direction on the back to back labyrinth, and removal of the vaned diffusers on all stages were made simultaneously. The compressor is operating with satisfactory vibration levels

E.A.K

**N85-14118\*#** Southwest Research Inst., San Antonio, Tex  
**SUBSYNCHRONOUS VIBRATIONS IN A HIGH PRESSURE CENTRIFUGAL COMPRESSOR: A CASE HISTORY**

B. F. EVANS and A. J. SMALLEY. In NASA Lewis Research Center Rotordynamic Instability Problems in High-Performance Turbomachinery p 17-36 Dec 1984 refs

Avail: NTIS HC A22/MF A01 CSCL 131

Two distinct aerodynamically excited vibrations in a high pressure low flow centrifugal compressor are documented. A measured vibration near 21% of running speed was identified as a nonresonant forced vibration which results from rotating stall in the diffuser, a measured vibration near 50% of running speed was identified as a self excited vibration sustained by cross coupling forces acting at the compressor wheels. The dependence of these characteristics on speed, discharge pressure, and changes in bearing design are shown. The exciting mechanisms of diffuser stall and aerodynamic cross coupling are evidenced. It is shown how the rotor characteristics are expected to change as a result of modifications. The operation of the compressor after the modifications is described

E.A.K

**N85-14119\*# Engineering Dynamics, Inc., San Antonio, Tex  
EXPERIENCES WITH NONSYNCHRONOUS FORCED  
VIBRATION IN CENTRIFUGAL COMPRESSORS**

D. R. SMITH and J. C. WACHEL /in NASA. Lewis Research Center Rotordynamic Instability Problems in High-Performance Turbomachinery p 37-52 Dec. 1984 refs  
Avail NTIS HC A22/MF A01 CSCL 131

The high subsynchronous vibrations which are often forced vibrations caused by flow instabilities, such as stage stall were examined. Modifications to improve the rotor stability by changing the bearings or seals have little effects on the subsynchronous vibrations. Understanding of the differences between forced vibrations and self excited vibrations to properly diagnose the problem and to correct it, is recommended. A list of characteristics of the two types of subsynchronous vibration is presented.

E A K

**N85-14120\*# Avco Lycoming Div., Stratford, Conn  
CONTROL OF ROTORDYNAMIC INSTABILITY IN A TYPICAL  
GAS TURBINE'S POWER SYSTEM**

N. M. VEIKOS, R. H. PAGE, and E. J. TORNILLO /in NASA. Lewis Research Center Rotordynamic Instability Problems in High-Performance Turbomachinery p 53-80 Dec 1984 refs  
Avail NTIS HC A22/MF A01 CSCL 131

The effect of rotor internal friction on the system's stability was studied when operated above the first critical speed. This internal friction is commonly caused by sliding press fits or sliding splines. Under conditions of high speed and low bearing damping, these systems will occasionally whirl at a frequency less than the shaft's rotational speed. This subsynchronous precession is a self excited phenomenon and stress reversals are created. This phenomenon was observed during engine testing. The reduction of spline friction and/or the inclusion of squeeze film damping have controlled the instability. Case history and the detail design of the squeeze film dampers is discussed.

E A K

**N85-14121\*# Exxon Chemical Co., Inc., Baytown, Tex  
EXPERIMENTAL ON-STREAM ELIMINATION OF RESONANT  
WHIRL IN A LARGE CENTRIFUGAL COMPRESSOR**

G. I. BHAT and R. G. EIERMAN /in NASA. Lewis Research Center Rotordynamic Instability Problems in High-Performance Turbomachinery p 81-95 Dec. 1984 refs  
Avail NTIS HC A22/MF A01 CSCL 131

Resonant whirl condition during operation of a multi-stage centrifugal compressor at higher than anticipated speeds and loads was reported. The condition was diagnosed by a large scale computerized Machinery Condition Monitoring System (MACMOS). This computerized system verified that the predominant subsynchronous whirl frequency locked in on the first resonant frequency of the compressor rotor and did not vary with compressor speed. Compressor stability calculations showed the rotor system had excessive bearing stiffness and inadequate effective damping. An optimum bearing design which was developed to minimize the unbalance response and to maximize the stability threshold is presented.

E A K

**N85-14122\*# National Aeronautics and Space Administration  
Lewis Research Center, Cleveland, Ohio  
INTERNAL HYSTERESIS EXPERIENCED ON A HIGH PRESSURE  
SYN GAS COMPRESSOR**

F. Y. ZEIDAN (Qatar Fertiliser Co., Umm Said) /in its Rotordynamic Instability Problems in High-Performance Turbomachinery p 97-108 Dec 1984 refs  
Avail NTIS HC A22/MF A01 CSCL 131

A vibration instability phenomenon experienced in operating high pressure syn gas centrifugal compressors in two ammonia plants is described. The compressors were monitored by orbit and spectrum analysis for changes from baseline readings. It is found that internal hysteresis was the major destabilizing force; however, the problem was further complicated by seal lockup at the suction end of the compressor. A coupling lockup problem and a coupling fit problem, which fretage of the shaft, are also considered as contributors to the self excited vibrations.

E A K

**N85-14123\*# California Inst of Tech, Pasadena.  
LATERAL FLUID FORCES ACTING ON A WHIRLING  
CENTRIFUGAL IMPELLER IN VANELESS AND VANED  
DIFFUSER**

H. OHASHI and H. SHOJI (Tsukuba Univ., Japan) /in NASA. Lewis Research Center Rotordynamic Instability Problems in High-Performance Turbomachinery p 109-122 Dec 1984  
Avail NTIS HC A22/MF A01 CSCL 131

Fluid forces on a rotating centrifugal impeller in whirling motion were studied. A two dimensional impeller installed in a parallel-walled vaneless and vaned diffuser whirled on a circular orbit with various positive and negative angular velocities. It is shown that the fluid forces exert a damping effect on the rotor in most operating conditions, but become excitatory when the impeller operates at very low partial discharge while rotating far faster than the whirl speed. The fluid forces were expressed in terms of mass, damping and stiffness matrices. Impellers with the same geometry and whirl condition are calculated. Quantitative agreement is obtained especially in positive whirl.

E A K

**N85-14124\*# Virginia Univ., Charlottesville  
HYDRAULIC FORCES ON A CENTRIFUGAL IMPELLER  
UNDERGOING SYNCHRONOUS WHIRL**

P. E. ALLAIRE, C. J. SATO (BE & IC Engineering Co., Birmingham, Ala.), and L. A. BRANAGAN (Pacific Gas and Electric Co., San Ramon, Calif) /in NASA. Lewis Research Center Rotordynamic Instability Problems in High-Performance Turbomachinery p 123-136 Dec 1984 refs  
Avail NTIS HC A22/MF A01 CSCL 131

High speed centrifugal rotating machinery with large vibrations caused by aerodynamic forces on impellers was examined. A method to calculate forces in a two dimensional orbiting impeller in an unbounded fluid with nonuniform entering flow was developed. A finite element model of the full impeller is employed to solve the inviscid flow equations. Five forces acting on the impeller are: Coriolis forces, centripetal forces, changes in linear momentum, changes in pressure due to rotation and pressure changes due to linear momentum. Both principal and cross coupled stiffness coefficients are calculated for the impeller.

E A K

**N85-14125\*# California Inst. of Tech., Pasadena.  
HYDRODYNAMIC IMPELLER STIFFNESS, DAMPING, AND  
INERTIA IN THE ROTORDYNAMICS OF CENTRIFUGAL FLOW  
PUMPS**

S. JERY, A. J. ACOSTA, C. E. BRENNEN, and T. K. CAUGHEY /in NASA. Lewis Research Center Rotordynamic Instability Problems in High-Performance Turbomachinery p 137-160 Dec 1984 refs  
Avail NTIS HC A22/MF A01 CSCL 131

The lateral hydrodynamic forces experienced by a centrifugal pump impeller performing circular whirl motions within several volute geometries were measured. The lateral forces were decomposed into (1) time averaged lateral forces and (2) hydrodynamic force matrices representing the variation of the lateral forces with position of the impeller center. It is found that these force matrices essentially consist of equal diagonal terms and skew symmetric off diagonal terms. One consequence of this is that during its whirl motion the impeller experiences forces acting normal and tangential to the locus of whirl. Data on these normal and tangential forces are presented, it is shown that there exists a region of positive reduced whirl frequencies, within which the hydrodynamic forces can be destabilizing with respect to whirl.

E A K

**N85-14132\*# General Electric Co., Schenectady, N. Y.  
PRELIMINARY INVESTIGATION OF LABYRINTH PACKING  
PRESSURE DROPS AT ONSET OF SWIRL-INDUCED ROTOR  
INSTABILITY**

E. H. MILLER and J. H. VOHR /in NASA. Lewis Research Center Rotordynamic Instability Problems in High-Performance Turbomachinery p 281-294 Dec 1984 refs  
Avail NTIS HC A22/MF A01 CSCL 131

Backward and forward subsynchronous instability was observed in a flexible model test rotor under the influence of swirl flow in a

straight-through labyrinth packing. The packing pressure drop at the onset of instability was then measured for a range of operating speeds, clearances and inlet swirl conditions. The trend in these measurements for forward swirl and forward instability is generally consistent with the short packing rotor force formulations of Bencherit and Wachter. Diverging clearances were also destabilizing and had a forward orbit with forward swirl and a backward orbit with reverse swirl. A larger, stiff rotor model system is now being assembled which will permit testing steam turbine-type straight-through and hi-lo labyrinth packings. With calibrated and adjustable bearings in this new apparatus, direct measure of the net destabilizing force generated by the packings can be made.

Author

**N85-14134\*# Texas A&M Univ., College Station  
ANALYSIS AND TESTING FOR ROTORDYNAMIC  
COEFFICIENTS OF TURBULENT ANNULAR SEALS WITH  
DIFFERENT, DIRECTIONALLY HOMOGENEOUS  
SURFACE-ROUGHNESS TREATMENT FOR ROTOR AND  
STATOR ELEMENTS**

D. W. CHILDS and C. H. KIM. In NASA Lewis Research Center Rotordynamic Instability Problems in High-Performance Turbomachinery p 313-340 Dec 1984 refs  
Avail: NTIS HC A22/MF A01 CSCL 11A

A theory is presented, based on a simple modification of Hirs' turbulent lubrication equations, to account for different but directionally-homogeneous surface roughness treatments for the rotor and stator of annular seals. The theoretical results agree with von Pragenau's predictions that a damper seal which uses a smooth rotor and a rough stator yields more net damping than a conventional seal which has the same roughness for both the rotor and stator. Experimental results for four stators confirm that properly-designed roughened stators yield higher net damping values and substantially less leakage than seals with smooth surfaces. The best seal from both damping and leakage viewpoints uses a round-hole-pattern stator. Initial results for this stator suggest that, within limits, seals can be designed to yield specified ratios of stiffness to damping.

Author

**N85-14135\*# Texas A&M Univ., College Station  
ANALYSIS FOR LEAKAGE AND ROTORDYNAMIC  
COEFFICIENTS OF SURFACE ROUGHENED TAPERED  
ANNULAR GAS SEALS**

C. C. NELSON. In NASA Lewis Research Center Rotordynamic Instability Problems in High-Performance Turbomachinery p 341-350 Dec 1984 refs  
Avail: NTIS HC A22/MF A01 CSCL 11A

In order to soften the effects of rub, the smooth stators of turbine gas seals are sometimes replaced by a honeycomb surface. This deliberately roughened stator and smooth rotor combination retards the seal leakage and may lead to enhanced rotor stability. However, many factors determine the rotordynamic coefficients and little is known as to the effectiveness of these honeycomb seals under various changes in the independent seal parameters. An analytical-computational method to solve for the rotordynamic coefficients of this type of compressible-flow seal is developed. The governing equations for surface roughened tapered annular gas seals are based on a modified Hirs' turbulent bulk flow model. A perturbation analysis is employed to develop zeroth and first-order perturbation equations. These equations are numerically integrated to solve for the leakage, pressure, density, and velocity for small motion of the shaft about the centered position. The resulting pressure distribution is then integrated to find the corresponding rotor-dynamic coefficients.

Author

**N85-14658# Joint Publications Research Service, Arlington, Va  
PROCEDURAL ASPECTS OF TESTING AERODYNAMIC  
MODELS WITH COMBUSTION IN HIGH-ENTHALPY  
TRANSIENT-MODE INSTALLATIONS Abstract Only**

V. K. BAYEV, V. V. SHUMSKIY, and M. I. YAROSLAVTSEV. In its USSR Rept Phys and Math (JPRS-UPM-84-007) p 20 18 Oct 1984 Transl into ENGLISH from Izv Sib Otd Akad Nauk SSSR, Ser. Tekh Nauk, no 4, issue 1, Mar. 1984 p 68-77  
Avail: NTIS HC A06

Feed, wind-tunnel balance, pressure, and heat flow instrumentation systems are developed for short-term testing of various models with combustion for different relative positions of the nozzle, the models and the systems that support the models and instrumentation complex. The models are tested in an IT-301 pulsed wind tunnel with various media being input to the model. The models examined are a flat plate for studying spontaneous ignition of fuel media, or gasdynamic models for investigating the gas dynamics of supplying heat to the channel of the model. A feed system based on the electrohydraulic effect is developed. The methods used to study the force characteristics and pressure in the models are described.

Author

**N85-14951# Thermo Electron Corp., Waltham, Mass  
OPEN-CYCLE VAPOR COMPRESSION HEAT PUMP Annual  
Report, Apr. 1983 - Apr. 1984**

F. E. BECKER and A. E. RUGGLES. May 1984 57 p refs  
Sponsored by Gas Research Inst.  
(PB85-101475/GAR, TE4224-106-84, GRI-84/0130) Avail: NTIS HC A04/MF A01 CSCL 13A

Large quantities of low-grade energy in the form of low-pressure steam and low-temperature heat are wasted by industry. The practical and economical recovery of energy from these sources is often limited by the number of applications for the use of low-temperature heat. Thermo Electron has developed an open-cycle steam heat pump system capable of the direct recovery and upgrading of low-grade waste steam. The system compresses low-pressure waste steam (or steam made from sources of low-temperature waste heat) to produce high-pressure steam suitable for use in industrial processes. A prototype system was developed that is capable of recovering and recompressing up to 10,000 lb/hr of waste steam, while using only 50 percent of the fuel that would be required to produce comparable steam in a boiler. The prototype steam recompression system, using a 2200-cfm rotary screw compressor driven by a 500-hp natural gas engine, was tested for a yearlong field test.

GRA

**N85-14954# Joint Publications Research Service, Arlington, Va  
USSR REPORT: ENGINEERING AND EQUIPMENT Abstracts  
Only**

14 Nov. 1984 67 p Transl into ENGLISH from various Russian articles  
(JPRS-UEQ-84-007) Avail: NTIS HC A04/MF A01

Abstracts of articles address specific topics in several branches of engineering are presented. The subject areas include aeronautical and space engineering, nuclear and non-nuclear energy technology, industrial technology, turbine and engine design, guidance, high energy devices and optics, fluid mechanics, and structural and materials science.

**N85-15056# Joint Publications Research Service, Arlington, Va  
MICROSTRIP ANTENNA FOR MULTICHANNEL RADIOMETER  
Abstract Only**

S. T. KNYAZEV, Y. I. NEFEDOV, and B. A. PANCHENKO. In its USSR Rept: Electron and Elec Eng (JPRS-UEE-84-011) p 9 25 Sep. 1984 Transl into ENGLISH from Izv Vyssh Ucheb. Zaved, Radioelektron (Kiev), v. 27, no. 2, Feb. 1984 p 86-87  
Avail: NTIS HC A07/MF A01

A microstrip designed for installation aboard agricultural aircraft as part of a radiometric moisture meter operating in the 2, 18 and 30 bands is described, which provides minimum losses and has no horizontal side lobes. The basic parameters of the experimental array patterns at the center and boundary frequencies of the working bands are given. The use of microstrip radiators makes it

possible to implement a moisture meter antenna system with superior operating and electrodynamic characteristics Author

**N85-15057#** Joint Publications Research Service, Arlington, Va  
**ALGORITHM FOR TRACKING MANUEVERING OBJECT WITH AMBIGUOUS MEASUREMENTS Abstract Only**  
*In its* USSR Rept Electron and Elec Eng (JPRS-UEE-84-011)  
 p 9 25 Sep 1984 Transl. into ENGLISH from Izv Vyssh Ucheb Zaved, Radioelektron. (Kiev), v 27, no 3, Mar 1984 p 3-8 Original language document announced as A84-28061  
 Avail: NTIS HC A07/MF A01

A quasi-optimal algorithm for the trajectory tracking of a maneuverable target in the presence of peripheral measurements is described. The method used is an adaptive state-estimation procedure based on a group of Kalman filters operating in parallel. Simulation results are presented B J (IAA)

**N85-15101#** Federal Aviation Administration, Atlantic City, N.J. Technical Center  
**THE EFFECT OF AIRCRAFT GENERATED ELECTROMAGNETIC INTERFERENCE (EMI) ON FUTURE AVIONICS SYSTEMS: A COMPENDIUM**  
 W E LARSEN, ed and N O RASCH Apr. 1984 327 p  
 Proceedings of Conf. held in Seattle, 19-21 Oct 1982  
 (AD-A146380, DOT/FAA/CT-84/9) Avail NTIS HC A15/MF A01 CSCL 20N

There are various commercial standards and specifications which are aimed at making aircraft compatible with a hostile electromagnetic environment. However, most of these standards and specifications were developed for analog circuitry, before the advent of high-speed flight critical digital systems. These standards must now be reengineered to accommodate the new technology of composites and sensitive integrated micro-electronic architectures. Modern aircraft are experiencing many cases of flights into or near heavy electromagnetic fields from various sources such as lightning, switching of heavy aircraft electrical loads, or radio transmissions during their life span. This EMI environment has caused and is causing hazardous incidents to aircraft by impairing the normal operation of some flight-critical and flight-essential equipment. Special precautions must also be taken to protect this sensitive digital avionics during maintenance operations. For this reason these standards and specifications must be revised and new design, manufacturing, and testing methods introduced G R A

**N85-15132** Rolls-Royce Ltd, London (England)  
**LAMINAR SEPARATION BUBBLE WITH TRANSITION: PREDICTION TEST WITH LOCAL INTERACTION**  
 C GLEYZES 8 Nov 1984 30 p refs Transl. into ENGLISH of French document  
 (BLL-PNR-90231-(8019.3153)) Avail British Library Lending Div, Boston Spa, Engl

The experimental results of a study of a leading edge separation bubble on a peaky airfoil are presented. Boundary layer measurements, mean velocity and longitudinal turbulence intensity were recorded at various values of Reynolds number (100,000 R sub c 1,000,000). Results of a study of the transition process in a long bubble are presented. Two calculation methods applicable to short bubbles are proposed. They both use a simple local viscid-inviscid interaction scheme. These results are compared to the experimental ones R S F

**N85-15133\*#** National Aeronautics and Space Administration  
 Lewis Research Center, Cleveland, Ohio  
**HEAT TRANSFER RESULTS AND OPERATIONAL CHARACTERISTICS OF THE NASA LEWIS RESEARCH CENTER HOT SECTION CASCADE TEST FACILITY**  
 H J GLADDEN, F C YEH, and D L FRONEK 1985 20 p  
 refs Presented at the 30th Intern. Gas Turbine Conf and Exhibit, Houston, Tex., 17-21 Mar 1985, sponsored by ASME  
 (NASA-TM-86890, E-2357, NAS 1.15 86890) Avail NTIS HC A02/MF A01 CSCL 20D

The NASA Lewis Research Center gas turbine hot section test facility has been developed to provide a real-engine environment with well known boundary conditions for the aerothermal performance evaluation/verification of computer design codes. The initial aerothermal research data obtained are presented and the operational characteristics of the facility are discussed. This facility is capable of testing at temperatures and pressures up to 1600 K and 18 atm which corresponds to a vane exit Reynolds number range of 0.5x10(6) to 2.5x10(6) based on vane chord. The component cooling air temperature can be independently modulated between 330 and 700 K providing gas-to-coolant temperature ratios similar to current engine application. Research instrumentation of the test components provide conventional pressure and temperature measurements as well as metal temperatures measured by IR-photography. The primary data acquisition mode is steady state through a 704 channel multiplexer/digitizer. The test facility was configured as an annular cascade of full coverage filmcooled vanes for the initial series of research tests Author

**N85-15135\*#** National Aeronautics and Space Administration.  
 Ames Research Center, Moffett Field, Calif  
**A COLLECTION OF FLOW VISUALIZATION TECHNIQUES USED IN THE AERODYNAMIC RESEARCH BRANCH**  
 Dec 1984 35 p Original contains color illustrations  
 (NASA-TM-85998, A-9840, NAS 1.15 85998) Avail NTIS HC A03/MF A01 CSCL 20D

Theoretical and experimental research on unsteady aerodynamic flows is discussed. Complex flow fields that involve separations, vortex interactions, and transonic flow effects were investigated. Flow visualization techniques are used to obtain a global picture of the flow phenomena before detailed quantitative studies are undertaken. A wide variety of methods are used to visualize fluid flow and a sampling of these methods is presented. It is emphasized that the visualization technique is a thorough quantitative analysis and subsequent physical understanding of these flow fields E.A K

**N85-15137#** Potter (J. Leith), Nashville, Tenn  
**REVIEW OF REQUIREMENTS AND STATUS OF SIMULATION AND SCALING OF TRANSONIC, VISCOUS FLOWS Final Report, 24 Aug. 1983 - 19 Mar. 1984**  
 J L POTTER Sep 1984 61 p  
 (AD-A146357, AEDC-TR-84-23) Avail NTIS HC A04/MF A01 CSCL 20D

The elements of transonic, viscous-flow simulation are reviewed, documented, and briefly evaluated in the light of newer results from research in this field. Not only the case of wing flows at low angles of attack, but also the problems arising with wings and fuselages or missiles at higher angles are discussed. Criteria to be satisfied in scale-model testing and means for doing that are the principal topics covered. This includes the experimental techniques for simulating shock wave-boundary layer interaction, obtaining full-scale shock location and overall aerodynamic coefficients, and the precautions associated with boundary layer tripping in various types of testing. Vortical flows receive attention, and the requirement for assessing Reynolds number effects is emphasized. The review brings together information from diverse sources that wind tunnel test planners need in further improving experimental results and which is also critical in extrapolating those data to full-scale flight conditions. The subject of this report will continue to be of concern even though capabilities in computational fluid dynamics are rapidly growing, and the recently dedicated

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National Transonic Facility at the Langley Research Center will provide much increased test Reynolds numbers. Author (GRA)

**N85-15144\*#** National Aeronautics and Space Administration Langley Research Center, Hampton, Va  
**INVESTIGATION OF LIGHT SOURCE AND SCATTERING MEDIUM RELATED TO VAPOR-SCREEN FLOW VISUALIZATION IN A SUPERSONIC WIND TUNNEL**

W. L. SNOW and O. A. MORRIS Dec. 1984 66 p refs  
(NASA-TM-86290; L-15836; NAS 1.15:86290) Avail NTIS HC A04/MF A01 CSCL 14B

Methods for increasing the radiant in light sheets used for vapor screen set-ups were investigated. Both high-pressure mercury arc lamps and lasers were considered. Pulsed operation of the air-cooled 1-kW lamps increased the light output but decreased reliability. An ellipsoidal mirror improved the output of the air-cooled lamps by concentrating the light but increased the complexity of the housing. Water-cooled 4-kW lamps coupled with high-aperture Fresnel lenses provided reasonable improvements over the air-cooled lamps. Fanned laser beams measurements of scattered light versus dew point made in conjunction with successful attempts to control the fluid injection. A number of smoke generators are described and test results comparing smoke and vapor screens are shown. Finally, one test included a periscope system to relay the image to a camera outside the flow. Author

**N85-15145#** Aeronautical Research Labs., Melbourne (Australia).

**A PRELIMINARY STUDY OF USING A STRAIN-GAUGED BALANCE AND PARAMETER ESTIMATION TECHNIQUES FOR THE DETERMINATION OF AERODYNAMIC FORCES ON A MODEL IN A VERY SHORT DURATION WIND TUNNEL**

A. P. BROWN and R. A. FEIK Dec. 1983 32 p  
(AD-A146473; ARL/AERO-TM-358) Avail NTIS HC A03/MF A01 CSCL 20D

This memo presents a preliminary study of a proposed method of measuring the aerodynamic forces on a supported model in an intermittent very short duration wind tunnel with a relatively high airflow dynamic pressure (of the orders of 200 microsec and 1/3 atmosphere respectively). A semiconductor strain gauged cantilever beam balance is used to record strain time histories associated with model displacement in response to aerodynamic force. The practical feasibility of obtaining sufficiently resolvable strains for the prescribed tunnel conditions with the given strain gauge configuration is established. The proposed method uses a system identification procedure to determine the system dynamic response characteristics using a known calibration force input. Subsequently, aerodynamic forces during a tunnel run follow from the recorded strain gauge time histories. The procedure has been demonstrated successfully using simulated data. However, the experimental situation did not lead to a successful analysis in the way proposed. Reasons for this are discussed and recommendations made for improvements. A brief series of shots in the ANU free piston shock tunnel also highlights the need to isolate as much as possible the model/balance from external vibrations. Author (GRA)

**N85-15184\*#** National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

**THE USE OF AN OPTICAL DATA ACQUISITION SYSTEM FOR BLADED DISK VIBRATION ANALYSIS**

C. LAWRENCE and E. H. MEYN Dec. 1984 23 p refs  
(NASA-TM-86891; E-2358; NAS 1.15:86891) Avail NTIS HC A02/MF A01 CSCL 20K

A new concept in instrumentation was developed by engineers at NASA Lewis Research Center to collect vibration data from multi-bladed rotors. This new concept, known as the optical data acquisition system, uses optical transducers to measure bladed tip deflections by reflection light beams off the tips of the blades as they pass in front of the optical transducer. By using an array of transducers around the perimeter of the rotor, detailed vibration signals can be obtained. In this study, resonant frequencies and mode shapes were determined for a 56 bladed rotor using the optical system. Frequency data from the optical system was also

compared to data obtained from strain gauge measurements and finite element analysis and was found to be in good agreement.

Author

**N85-15187#** National Aerospace Lab., Tokyo (Japan).  
**VERIFICATION OF A COMPUTER PROGRAM FOR VIBRATION ANALYSIS OF COMPOSITE WING CORES**

Y. NOGUCHI and T. ISHIKAWA Jul. 1984 24 p refs In JAPANESE; ENGLISH summary  
(NAL-TR-825; ISSN-0389-4010) Avail NTIS HC A02/MF A01

A finite element program developed for vibration analysis of composite wing cores was examined. Such cores are used in a research project on aeroelastic tailoring. The formulation of the finite element analysis is presented. Basic elastic moduli of composites are discussed to confirm their reliability of the input data for the verification. All moduli are determined by experimental procedures and theoretical bases of such experimentation are given. Composite wing cores are consolidated with unidirectional tapes into pure unidirectional plates of different fiber directions and multidirectional laminates. A flutter model is idealized as a composite plate with added lumped masses. E. A. K.

**N85-15189#** Pratt and Whitney Aircraft, West Palm Beach, Fla Government Products Div

**CONSTITUTIVE MODELING OF ENGINE MATERIALS Final Report, Jul. 1981 - Oct. 1983**

D. A. WILSON and K. P. WALKER Wright-Patterson AFB, Ohio AFWAL Jul. 1984 84 p  
(Contract F33615-81-C-5040)  
(AD-A146630; AFWAL-TR-84-4073) Avail NTIS HC A05/MF A01 CSCL 20K

This investigation examines the capability to predict the growth of cracks in critical structural components operating at elevated temperatures where time-dependent behavior occurs. A viscoplastic constitutive model for INCO 718 was developed to determine this behavior in the area of the crack tip. The model constants were obtained from monotonically increasing, cyclic, and sustained loading. Therefore, the model has the capability to account for load history effects as well as material damage accumulation. Theoretical predictions are compared to the experimental results.

Author (GRA)

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### GEOSCIENCES

Includes geosciences (general), earth resources; energy production and conversion, environment pollution, geophysics, meteorology and climatology, and oceanography

**A85-16236\*#** National Aeronautics and Space Administration, Marshall Space Flight Center, Huntsville, Ala

**A SPATIAL MODEL OF WIND SHEAR AND TURBULENCE**

C. W. CAMPBELL (NASA, Marshall Space Flight Center, Systems Dynamics Laboratory, Huntsville, AL) and V. A. SANBORN (Colorado State University, Fort Collins, CO) Journal of Aircraft (ISSN 0021-8669), vol. 21, Dec. 1984, p. 929-935. refs  
(AIAA PAPER 84-0277)

The purpose of the spatial model considered in the present investigation is to generate the wind environment for use by others for flight simulation. Winds and gusts are provided over any finite area (e.g., aircraft body) from which aircraft loads and moments may be calculated. Three-dimensional autospectral information and correlation are contained in the data. It is pointed out that the three-dimensionality as contained in the spatial model affords much greater realism than widely used one-dimensional models. The resulting simulated wind is a nonlinear, non-Gaussian combination of real atmospheric winds and Gaussian, three-dimensional turbulence modulated by gust intensities which may vary freely as desired over space. The turbulence as represented by a product

of a varying gust intensity and simulated turbulence is nonlinear and non-Gaussian. G R

#### A85-16256

##### EFFECT OF SONIC BOOM ON A CRACKED PLASTER-WOOD WALL

N N. WAHBA (Toronto, University, Downsview, Ontario, Canada) IN: Structural failure, product liability and technical insurance, Proceedings of the First International Conference, Vienna, Austria, September 26-29, 1983 Amsterdam, North-Holland, 1984, p. 227-233.

The effect of a sonic boom (as generated by a supersonic aircraft) on on-land structures is examined experimentally, using a traveling-wave horn-type sonic boom simulator. Five types of horizontal artificial crack configurations of varying length were tested, with strain measurements taken at the crack tip, at 1.6, 8.0, and 14.3 mm away from the crack tip in the direction of the crack, and at the center of the wall. Fracture tests are also presented, which apply a cylindrical bending moment to a plaster plate. It is concluded that the propagation of a crack in a plaster-wood wall due to an aircraft sonic boom is unlikely, except in extraordinary circumstances. L T

#### A85-17485

##### USE OF DOPPLER RADAR TO DETECT WEATHER HAZARDS SUCH AS TURBULENCE, WIND SHEAR, AND GUST FRONTS

J T. LEE (NOAA, National Severe Storms Laboratory, Norman, OK) IN: 1983 International Geoscience and Remote Sensing Symposium (IGARSS '83), San Francisco, CA, August 31-September 2, 1983, Digest Volume 1 New York, Institute of Electrical and Electronics Engineers, Inc., 1983, 7 p. refs

The ability of Doppler radar to determine wind shear, vortices, and turbulence in thunderstorms is discussed. The Doppler radar's ability to monitor clear air motion, to determine areas where convection is beginning, and to observe clear air gust fronts is shown by relating actual examples. C.D

#### A85-17486

##### SCAN RATES OF NEXT GENERATION WEATHER RADAR

P R. MAHAPATRA (Indian Institute of Science, Bangalore, India) and D S. ZRNIC (NOAA, National Severe Storms Laboratory, Norman, OK) IN: 1983 International Geoscience and Remote Sensing Symposium (IGARSS '83), San Francisco, CA, August 31-September 2, 1983, Digest Volume 1 New York, Institute of Electrical and Electronics Engineers, Inc., 1983, 6 p. refs

This paper presents the methodology and results of a study to estimate the lifetimes of significant features in storms. These results are expected to help in deciding the scan strategy of NEXRAD radars. In particular, the adequacy of a 5-minute scan cycle for NEXRAD in its air weather role is addressed. Two methods are used for the lifetime study: photo-interpretive and computer-based correlation. Several storms are studied using both methods. It is found that the storms studied contain no feature that might have been missed by a 5-minute scan cycle provided that data from all the three moment fields (reflectivity, radial velocity and Doppler spectrum width) at several elevations are utilized in the detection of hazardous phenomena. Author

A85-18324\* National Aeronautics and Space Administration Marshall Space Flight Center, Huntsville, Ala.

##### SEVENTH ANNUAL WORKSHOP ON METEOROLOGICAL AND ENVIRONMENTAL INPUTS TO AVIATION SYSTEMS 26-28 OCTOBER 1983, TULLAHOMA, TENNESSEE

D. W. CAMP (NASA, Marshall Space Flight Center, Systems Dynamics Laboratory, Huntsville, AL) and W. FROST (Tennessee, University, Space Institute, Tullahoma, TN) American Meteorological Society, Bulletin (ISSN 0003-0007), vol. 65, Nov. 1984, p. 1214-1218 refs

A summary of reports and recommendations resulting from the Workshop on Meteorological and Environmental Inputs to Aviation Systems is presented. The Workshops have been held to characterize the interaction between aircraft and airport operators with the atmosphere, identify necessary meteorological

enhancements, and establish criteria for meteorological data needed by the aviation community. The topics covered included winds and wind shear, turbulence, fog, visibility and ceiling, lightning and atmospheric electricity, icing, frost and snow, rain, ozone and acid rain. The recommendations issued included a denser meteorological network with more automated stations, the development of radar systems for icing forecasts and wind shear alerts, the accumulation of a greater data base on convective cells and lightning strikes, and further study of the impact of rain on aircraft performance. M S K

#### A85-18874

##### THE NOISE PROBLEM AND THE AIRPORT ENVIRONMENT [LE PROBLEME DU BRUIT ET DE L'ENVIRONNEMENT DES AEROPORTS]

R. LORIN (Aeroports de Paris, Paris, France) and M. WACHENHEIM (Direction Generale a l'Aviation Civile, Service Technique des Bases Aeriennes, Paris, France) Revue Generale des Routes et des Aerodromes (ISSN 0035-3191), vol. 58, Nov 1984, p. 65-74. In French.

A numerical index is defined for exposure to noise around an airport and used to consider noise pollution problems and solutions. Attention is given to sound profiles emitted during take-off and landing and along the approach and departure trajectories. The noise is affected by winds, division of the traffic among runways, the type of aircraft engines, and the distance from the source. When the influencing factors are analyzed, the noise level can be predicted, using the resulting indices, at any point around the airport. The construction of airports is then restricted by the projected locations of strong and moderate noise levels. Soundproofing can be added to existing buildings, but at costs which may be prohibitive. Tax incentives can be added, i.e., airlines can be taxed for not reducing noise. Approach routes can be changed and shuttered deflectors can redirect jet exhausts upward during takeoff. Techniques being explored to reduce jet engine noise at the source are discussed, with mention made of the progress made since transport aircraft were brought into service. M.S.K

N85-14420# Amt fuer Wehrgeophysik, Traben-Trarbach (West Germany).

##### TAF VERIFICATION (AIRPORT WEATHER FORECASTS) [TAF-VERIFIKATION]

H. WEINGAERTNER Jul 1984 39 p. In GERMAN (GEOPHYSBDBW-FM-205, ISSN-0342-6025) Avail: NTIS HC A03/MF A01

An airport weather forecast (TAF) verification procedure is described and the results for 42 airfields are presented. The TAF is verified with regard to horizontal visibility, the parameters being summarized in color-state classes. The quota for correct TAF is 73%. Scientific forecast performance is 62%, showing an exponential decrease from 76% (1st hour) to 49% (9th hour).

Author (ESA)

##### N85-15315# Naval Weapons Center, China Lake, Calif VISIBILITY MONITORING IN THE SOUTHERN CALIFORNIA DESERT FOR THE DEPARTMENT OF DEFENSE: RESEARCH ON OPERATIONS-LIMITING VISUAL EXTINCTION, RESOLVE PROTOCOL

D. BLUMENTHAL and J. TRIJONIS Sep 1984 38 p. (AD-A146617, NWC-TP-6566) Avail: NTIS HC A03/MF A01 CSCI 04A

A decrease in visibility in the R2508 airspace (in the western Mojave Desert in southern California) since the mid-1940s, when flight test and training facilities were established in this region, is adversely affecting flight and test operations. The Joint Policy and Planning Board (JPPB) of the Department of Defense has initiated studies and discussions of the visibility issue with the goal of developing a management strategy to maintain and optimize the operational capabilities of the test facilities. To identify trends in and sources of visibility degradation in the desert, JPPB initiated two programs: (1) a compilation and review of the historical visibility and air quality data in the California desert region, to be coordinated

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by the California Desert Air Working Group (CDAWG) and funded by CDAWG participants, and (2) RESEARCH on Operations-Limiting Visual Extinction (RESOLVE), which involves measuring the visibility at key receptor sites (monitoring stations) in the R2508 region. The report describes the current status of and future plans for the RESOLVE program. Author (GRA)

**N85-15319\*** Texas Technological Univ., Lubbock Dept of Electrical Engineering  
**ELECTROMAGNETIC RESONANCES OF CYLINDERS AND AIRCRAFT MODEL WITH RESISTIVE WIRES**  
G. W. WOOD and T. F. TROST Nov 1984 59 p refs  
(Contract NAG1-28)  
(NASA-CR-174203; NAS 1 26 174203) Avail: NTIS HC A04/MF A01 CSCL 04B

The natural frequencies of the electromagnetic resonances of conducting bodies with attached wires were determined. The bodies included two cylinders and an approximate scale model of the NASA F-106B aircraft. All were three feet in length. Time domain waveforms of  $B$ -dot and  $D$ -dot were obtained from a sampling oscilloscope, and Prony analysis was used to extract the natural frequencies. The first four natural frequencies of the cylinders (and wires) were determined, and a comparison with calculated results of other investigators shows reasonable agreement. Seven natural frequencies were determined for the F-106B model (with wires), and these were compared with results obtained by NASA in 1982 during direct lightning strikes to the aircraft. The agreement between the corresponding natural frequencies of the model and the aircraft is fairly good and is better than that obtained in the previous work using wires with less resistance. The frequencies lie between 6.5 MHz and 41 MHz, and all of the normalized damping rates are between 0.14 and 0.27. R.S.F.

**N85-15330#** National Severe Storms Lab., Norman, Okla  
**SPRING PROGRAM SUMMARY, 1983**  
J. T. DOOLEY, ed Apr 1984 66 p  
(PB84-222223, NOAA-TM-ERL-NSSL-96; NOAA-84071101)  
Avail: NTIS HC04/MF A01 CSCL 04B

The National Severe Storms Laboratory (NSSL) is involved both with the collection of data and its analysis. Principal objectives of the 1983 observation program were to: (1) acquire a dual Doppler data set from a tornadic and/or supercell status storm, (2) increase the data base of the Storm Electricity Group, (3) support other groups in experiments related to the electric field inside and around thunderstorms, (4) measure the structure of wind and reflectivity in clear air, (5) measure gust gradients in adverse meteorological conditions with special emphasis on airport approach and departure flight paths, (6) obtain tornado proximity data with the Totable Tornado Observatory (TOTO) and (7) measurement of parameters related to the boundary layer. GRA

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### MATHEMATICAL AND COMPUTER SCIENCES

Includes mathematical and computer sciences (general), computer operations and hardware; computer programming and software, computer systems; cybernetics; numerical analysis; statistics and probability, systems analysis; and theoretical mathematics.

**A85-17055**  
**A PROBLEM CONCERNING THE INCOMPLETE-FEEDBACK CONTROL OF LINEAR MARKOVIAN SYSTEMS WITH RANDOM PARAMETERS [OB ODNOI ZADACHE UPRAVLENIIA S NEPOLNOI OBRATNOI SVIAZ'U LINEINNYMI MARKOVSKIMI SISTEMAMI SO SLUCHAINYMI PARAMETRAMI]**  
V. K. BRUTIAN Aviatsonnaia Tekhnika (ISSN 0579-2975), no. 2, 1984, p. 21-26. In Russian. refs

In the problem considered here, linear Markovian controlled systems are to be synthesized using the negative feedback principle

in such a way as to minimize the conditional mathematical expectation of the quality functional, while satisfying the feedback equation under conditions of incomplete observations. The problem is solved using a two-step procedure. The approach proposed here is illustrated by an example involving an aircraft stabilization system. V. L.

**A85-17058**  
**OPTIMUM PARAMETRIC CONTROL OF OBJECTS WITH A LAGGING ARGUMENT [OPTIMAL'NOE PARAMETRICHESKOE UPRAVLENIE OB'EKTA MI S ZAPAZDYVAIUSHCHIM ARGUMENTOM]**  
G. L. DEGTIAREV Aviatsonnaia Tekhnika (ISSN 0579-2975), no. 2, 1984, p. 34-38. In Russian. refs

Many processes in the automatic control systems of modern aircraft are described by differential equations with a lagging argument. The problem considered here is that of determining the parameters of a control law in systems with a lagging argument in the case where state measurements are incomplete or inaccurate. A closed system of equations for determining parameters corresponding to the maximum accuracy of stabilization is obtained. V. L.

**A85-17065**  
**CALCULATION OF THE PROBABILISTIC CHARACTERISTICS OF NONLINEAR CONTROL SYSTEMS USING A TRIGONOMETRIC VERSION OF THE FACTORIAL INTERPOLATION METHOD [RASCHET VEROIATNOSTNYKH KHARAKTERISTIK Nelineinykh SISTEM UPRAVLENIIA S ISPOL'ZOVANIEM TRIGONOMETRICHESKOGO VARIANTA FAKTORNOGO INTERPOLIATSIONNOGO METODA]**  
A. V. SVILIN Aviatsonnaia Tekhnika (ISSN 0579-2975), no. 2, 1984, p. 68-72. In Russian. refs

A new version of the factorial interpolation method is presented which in many cases significantly increases the efficiency of calculations during a statistical analysis of nonlinear control systems. The algorithm proposed here is demonstrated by applying it to the stabilization system of an aircraft whose dynamics is described by a nonlinear equation. V. L.

**A85-17802#**  
**DEVELOPING SAFE SOFTWARE FOR CRITICAL AIRBORNE APPLICATIONS**

W. B. NOBLE (Hughes Aircraft Co., Ground Systems Group, Fullerton, CA) IN: Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings. New York, American Institute of Aeronautics and Astronautics, 1984, p. 1-5 (AIAA PAPER 84-2598)

Attention is given to recently developed methods for the integration of traditional hardware design and analysis techniques in software definition tasks aimed at safety-critical airborne applications where the reliability of complex, software-driven processes must be assured. Attention is given to flight control programs consisting of an infinite loop which, once entered, continues in execution and must repeat at a specific interval in order to implement flight control laws and logic. Since such a program is embedded within the computer system, it cannot be accessed or altered without special equipment. It is noted that the problems of flight safety and system reliability are distinct even though related. Two analytic techniques, fault trees, and a common mode analysis are presented. O. C.

**A85-17803#**  
**THE USE OF STRUCTURED METHODS IN THE DEVELOPMENT OF LARGE SOFTWARE-BASED AVIONICS SYSTEMS**  
D. J. HATLEY (Lear Siegler, Inc., Instrument Div., Grand Rapids, MI) IN: Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings. New York, American Institute of Aeronautics and Astronautics, 1984, p. 6-15. refs (AIAA PAPER 84-2595)

Large software-based avionics systems require multimode operation, direct interaction with a rapidly changing physical environment, and fast response times. Basic Yourdon methods



have been successfully extended to represent such requirements while preserving the rigor and simplicity of these methods, which, in business-related applications, employ a data-triggered processor model which actually deemphasizes critical control and timing requirements. Such extended methods are presently applied to the development of a commercial Flight Management Computer System yielding significant reductions in development times and improvements in the early achievement of full system performance, by comparison to those for previous, similar systems O C

#### A85-17806#

### ARCHITECTURAL SOLUTIONS TO SAFETY PROBLEMS OF DIGITAL FLIGHT CRITICAL SYSTEMS FOR COMMERCIAL TRANSPORTS

L J. YOUNT (Sperry Corp., Phoenix, AZ) IN Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings New York, American Institute of Aeronautics and Astronautics, 1984, p 28-35 refs (AIAA PAPER 84-2603)

This paper discusses the special advantages and problems encountered when critical functions of modern commercial transport aircraft are implemented with software rather than discrete hardware. The dissimilar processing techniques in the dual-dissimilar SP-300 flight control system of the 737-300 aircraft serve as a reference point for discussing the various advantages and disadvantages of dissimilar redundancy. The tendency in the industry to include fallback provisions in the form of discrete analog circuitry for critical functions is evidence of the problems and uncertainties that remain regarding critical software implementations. Techniques to overcome generic processor hardware and software faults are discussed. Also discussed are new concepts in processor-independent hardware monitors to ensure proper program execution in critical software systems. The emphasis in this paper is on architectural solutions to critical safety validation problems rather than on an exhaustive analysis. Particular architectures designed for fail-op and fail-op-squared, flight-critical systems that are exclusively dependent on software implementations, are analyzed Author

#### A85-17814#

### INTEGRATED TRACKING SOFTWARE FOR MULTIMODE OPERATION

J L FARRELL and D. A HEDLAND (Westinghouse Defense and Electronic Systems Center, Baltimore, MD) IN Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings New York, American Institute of Aeronautics and Astronautics, 1984, p 76-83 refs (AIAA PAPER 84-2614)

Estimation algorithms currently in use can employ common software for air-to-air and air-to-ground (fixed and moving target) modes. It is presently noted that a single tracking algorithm can be used to accomplish widely varying mission modes with considerably different input sources and accuracies, since only the initial settings of covariance matrix diagonal elements, filter time constants, and measurement variances are mode and/or sensor-dependent. The adaptability of this Kalman tracker is due to the use of Bierman's (1977) factorization algorithms O C

#### A85-17826#

### DEVELOPMENT TOOLS - CASE STUDY FOR LARGE SYSTEMS

K. HORNBAUGH (Lear Siegler, Inc., Instrument Div., Grand Rapids, MI) IN Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings New York, American Institute of Aeronautics and Astronautics, 1984, p 167-174 refs (AIAA PAPER 84-2635)

Software development tools can be an important aid in controlling the complexity of large digital avionics systems. This paper describes the successful application of modern software tools to the development of the Flight Management Computer System for the 737-300 aircraft. Tools were used to increase productivity and quality during the entire software life cycle. Source code management tools provided thorough, ongoing configuration

management of code. Static analysis and path coverage of the source aided in meeting stringent verification requirements. Fourth-generation language techniques were used to produce many of the tools cost-effectively and text-formatting tools were used to increase documentation productivity. These and other tools, some in use for the first time, helped in the production of a high quality software product on a very tight schedule. Special attention was paid to the problems of scaling up tools for use on a large project, and to careful tailoring of the tools to correspond to the specific ways the project chose to structure software development.

Author

#### A85-17827#

### MULTI-SENSOR SURVEILLANCE PERFORMANCE EVALUATION TOOL

C L BOWMAN and G. SNASHALL (VERAC, Inc., San Diego, CA) IN Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings New York, American Institute of Aeronautics and Astronautics, 1984, p 175-179 refs (AIAA PAPER 84-2631)

A software-based testbed for off-line verification of multispectral source data for beyond-visual range target detection is described. The sensors considered are part of military avionics and require multi-sensor integration (MSI) to extract range, rate and identification data for display to the pilot. The MSI testbed software estimates the memory requirements, software loading and latency, and the ability of the integrator to provide valid output in terms of ignoring transient events. The data arrive either synchronously or asynchronously and are queued for the fusion step, which is guided by a multiple level target class tree. The acceptability of a MSI is judged on the bases of the mission raid count, track accuracy, and target ID requirements over a given interval M S K

A85-17835\*# National Aeronautics and Space Administration Langley Research Center, Hampton, Va

### A VALIDATION METHODOLOGY FOR FAULT-TOLERANT CLOCK SYNCHRONIZATION

S C JOHNSON and R. W BUTLER (NASA, Langley Research Center, Hampton, VA) IN Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings New York, American Institute of Aeronautics and Astronautics, 1984, p 225-232 refs (AIAA PAPER 84-2648)

A validation method for the synchronization subsystem of a fault-tolerant computer system is presented. The high reliability requirement of flight crucial systems precludes the use of most traditional validation methods. The method presented utilizes formal design proof to uncover design and coding errors and experimentation to validate the assumptions of the design proof. The experimental method is described and illustrated by validating an experimental implementation of the Software Implemented Fault Tolerance (SIFT) clock synchronization algorithm. The design proof of the algorithm defines the maximum skew between any two nonfaulty clocks in the system in terms of theoretical upper bounds on certain system parameters. The quantile to which each parameter must be estimated is determined by a combinatorial analysis of the system reliability. The parameters are measured by direct and indirect means, and upper bounds are estimated. A nonparametric method based on an asymptotic property of the tail of a distribution is used to estimate the upper bound of a critical system parameter. Although the proof process is very costly, it is extremely valuable when validating the crucial synchronization subsystem. Author

## 15 MATHEMATICAL AND COMPUTER SCIENCES

**A85-17836\*** # National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif

### **TEST EXPERIENCE ON AN ULTRARELIABLE COMPUTER COMMUNICATION NETWORK**

L. W. ABBOTT (NASA, Flight Research Center, Edwards, CA) IN: Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings New York, American Institute of Aeronautics and Astronautics, 1984, p 233-238. refs (AIAA PAPER 84-2649)

The dispersed sensor processing mesh (DSPM) is an experimental, ultrareliable, fault-tolerant computer communications network that exhibits an organic-like ability to regenerate itself after suffering damage. The regeneration is accomplished by two routines - grow and repair. This paper discusses the DSPM concept for achieving fault tolerance and provides a brief description of the mechanization of both the experiment and the six-node experimental network. The main topic of this paper is the system performance of the growth algorithm contained in the grow routine. The characteristics imbued to DSPM by the growth algorithm are also discussed. Data from an experimental DSPM network and software simulation of larger DSPM-type networks are used to examine the inherent limitation on growth time by the growth algorithm and the relationship of growth time to network size and topology. Author

**A85-17837\*** # National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif.

### **ULTRARELIABLE FAULT-TOLERANT CONTROL SYSTEMS**

L. D. WEBSTER, R. A. SLYKHOUSE, L. A. BOOTH, JR., T. M. CARSON, G. J. DAVIS, and J. C. HOWARD (NASA, Ames Research Center, Moffett Field, CA) IN: Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings New York, American Institute of Aeronautics and Astronautics, 1984, p. 239-246. refs (AIAA PAPER 84-2650)

It is demonstrated that fault-tolerant computer systems, such as on the Shuttles, based on redundant, independent operation are a viable alternative in fault tolerant system designs. The ultrareliable fault-tolerant control system (UFTCS) was developed and tested in laboratory simulations of an UH-1H helicopter. UFTCS includes asymptotically stable independent control elements in a parallel, cross-linked system environment. Static redundancy provides the fault tolerance. A polling is performed among the computers, with results allowing for time-delay channel variations with tight bounds. When compared with the laboratory and actual flight data for the helicopter, the probability of a fault was, for the first 10 hr of flight given a quintuple computer redundancy, found to be 1 in 290 billion. Two weeks of untended Space Station operations would experience a fault probability of 1 in 24 million. Techniques for avoiding channel divergence problems are identified. M.S.K.

**A85-17840#**

### **THE IMPACT OF ADVANCED COMPUTATIONAL TECHNIQUES ON DIGITAL AVIONICS SIGNAL PROCESSOR PERFORMANCE**

W. M. VOJIR (Grumman Aerospace Corp., Bethpage, NY) IN: Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings New York, American Institute of Aeronautics and Astronautics, 1984, p 257-262. refs (AIAA PAPER 84-2653)

Techniques for defining more efficient signal processing (SP) computational algorithms for modern on-board microprocessors are described. Extensive use is made of the discrete Fourier transform in SP applications, solved usually by a fast Fourier transform or, more recently, with a Winograd algorithm. The Winograd algorithm may require the least processing capabilities from VHSIC, and involves only simple multiplication in an iterative approach to larger transformations. The penalties are higher I/O and programmability requirements. Transforms can also be shortened by replacing multiplication with shifting operations if the convolution theorem is satisfied. Simulation with better algorithms permits computer-aided engineering of avionics components which are more amenable to

expanded future system designs. Detailed simulations are, however, necessary for validating the flexible formats. M.S.K.

**A85-17849\*** # Stanford Univ., Calif

### **AUTOMATED BENCHMARK GENERATION BASED UPON A SPECIFICATION LANGUAGE**

N. RAJAN, S. E. FETIHI (Stanford University, Stanford, CA), and J. SAITO (NASA, Ames Research Center, Moffett Field, CA) IN: Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings New York, American Institute of Aeronautics and Astronautics, 1984, p. 312-318 (AIAA PAPER 84-2667)

The problem of validating and verifying digital flight control system (DFCS) software is addressed in this paper. A new specification language DIVERS is proposed, and is the keystone of the approach. This language consists of keywords where each keyword represents an element in the block diagram of a DFCS. DIVERS has a dictionary which contains all the keywords a DFCS designer might need. Translator programs convert the system specifications into an executable, high-level language program. The features of translators are discussed and are elucidated by examples. This language is used to describe a typical flight software module. Author

**A85-17860#**

### **A STANDARD COMPUTER BUS FOR MIL-STD-1750A AVIONICS COMPUTERS**

D. PENN, S. LEVY (Israel Aircraft Industries, Ltd., Tel Aviv, Israel), and E. LOKER (Elbit Computers, Ltd., Haifa, Israel) IN: Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings New York, American Institute of Aeronautics and Astronautics, 1984, p. 393-398. (AIAA PAPER 84-2679)

While MIL-STD-1750A describes an instruction set architecture (ISA), the application of this ISA requires the usage of a data and address bus system which permits efficient communication between the cpu, memory, and application oriented input/output devices. The data and address bus system design and implementation is influenced by the design of the cpu and main memory since these two devices, in general, are the main users of the bus system. The Lavi avionics system utilizes a standardized data and address bus system (called L-BUS) for use in the MIL-STD-1750A computers which are embedded in the various components of the avionics system. The L-BUS is described and is proposed as a potential standard bus for MIL-STD-1750A implementations. Author

**A85-17862#**

### **DATA BUS INTERFACE MIL-STD-1553B/ARINC 561**

J. E. SPIETH (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH) IN: Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings New York, American Institute of Aeronautics and Astronautics, 1984, p 405-411. (AIAA PAPER 84-2682)

The primary aerial refueling tanker aircraft of the Air Force is the KC-135. The first version of this aircraft flew in 1956, while currently various improvement programs are in progress to enable the aircraft to remain operational well past the year 2000. The Fuel Savings Advisory/Cockpit Avionics System (FSA/CAS) Program updates the present KC-135 cockpit with new avionics integrated via a MIL-STD-1553B Data Bus. The MIL-STD-1553B is a Defense Department military standard which sets the requirements for aircraft internal time division command/response multiplex data buses. The ARINC 561 characteristics defines an air transport Inertial Navigation System (INS). Attention is given to an integrated test bed for Air Force engineering evaluation and validation of the FSA/CAS's performance; the employed simulator, and ARINC 561 data bus messages. G.R.

A85-17900#

**GENERAL DYNAMICS CONVAIR DIVISION TOTALLY RECONFIGURABLE EMBEDDED COMPUTER**

L MARKERT, P HEDTKE, and J KUSEK (General Dynamics Corp, Convair Div, San Diego, CA) IN: Digital Avionics Systems Conference, 6th, Baltimore, MD, December 3-6, 1984, Proceedings. New York, American Institute of Aeronautics and Astronautics, 1984, p 646-652

(AIAA PAPER 84-2748)

Features of the totally reconfigurable embedded computer (TREC) continuously under development as a flexible controller for evolving weapon system avionics platforms are described. TREC is intended mainly for cruise missiles and so must meet weight, volume, power consumption and environmental conditions restrictions. Designed around the F9450 microprocessor, TREC accommodates Ada and JOVIAL languages and has an architecture that comprises master, slave memory, I/O and debug services subsystems. The internal bus has a 20-bit address bus and a 16-bit data bus. The system interfaces with a UNIX-based minicomputer for debug loading and setting system operational parameters. TREC is mounted in an EMP-shielded box and utilizes radiation resistant semiconductor technologies. M.S.K.

A85-18285#

**APPLICATION OF MODEL-FOLLOWING CONTROL SYNTHESIS TECHNIQUES TO DESIGN OF HYDRAULIC VELOCITY FLIGHT SIMULATION TABLE WITH ONE AXIS**

Y LI Northwestern Polytechnical University, Journal, vol 2, Oct 1984, p 461-472. In Chinese, with abstract in English. refs

Four model-following approaches are used to design a hydraulic velocity flight simulation table with one axis. The problem of how to introduce input into the synthesized regulator system is discussed. In order to obtain satisfactory closed-loop transient characteristics, a new method is introduced for choosing the weight matrices for real model-following and type zero perfect model-following. The weight matrices of the quadratic performance criterion are chosen according to given formulas. The resulting systems possess satisfactory dynamic character. C.D.

A85-18350#

**MODEL REDUCTION OF CONTROL SYSTEMS**

L R PUJARA (Wright State University, Dayton, OH) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol 8, Jan-Feb 1984, p 152-155. USAF-supported research. refs (AFWAL-TM-83-183-FIGC)

It is pointed out that the analysis and design of large-order control systems is quite tedious and costly. For this reason, it is desirable to replace a given large-order system with a lower-order system in such a way that the lower-order system retains the significant characteristics of the given system. The present investigation is concerned with a computer-aided method of simplifying single-variable control systems. The considered method represents a modification of the technique of Rao and Lamba (1974) which can be applied directly to control systems with either a pole or a zero at the origin. The proposed method is a one-step procedure and provides significant savings in computer time in comparison to cases involving the use of the McFIT model reduction technique. G.R.

A85-18442\*# National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif

**NAS - SUPERCOMPUTING MASTER TOOL FOR AERONAUTICS**

F R BAILEY (NASA, Ames Research Center, Numerical Aerodynamic Simulation Projects Office, Moffett Field, CA) Aerospace America (ISSN 0740-722X), vol 23, Jan. 1985, p 118-121.

Features, performance objectives and applications planned for the NASA National Aerodynamics Simulator (NAS) are outlined. NAS was conceived in the 1970s as a means to performing numerical aerodynamic simulations beyond the scope of wind tunnel testing for high-speed flight. Present supercomputers cannot deal with problems exhibiting strongly coupled viscous effects,

which are being increasingly more accurately represented by approximations to the full Navier-Stokes equations. Located at the NASA-Ames Center, the NAS will by 1990 comprise a distributed computer network capable of a 4 Gflop computing rate and have a memory capacity of 1 billion 64-bit words. Remote access to the system through UNIX-based microcomputers will be available through land lines and satellite links. New supercomputers will be tested on the system without disturbing ongoing work. The core machine will be a Cray-2 with a 2 Gflop rate. M.S.K.

A85-18716

**MISI - A GENERAL, MODULAR, AND INTERACTIVE FLIGHT VEHICLE SIMULATION PROGRAM [MISI - EIN ALLGEMEINES MODULARES UND INTERAKTIVES FLUGKÖRPER-SIMULATIONSPROGRAMM]**

G. SOMIESKI and B. UHRMEISTER (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Institut fuer Dynamik der Flugsysteme, Oberpfaffenhofen, West Germany) DVLN-Nachrichten (ISSN 0011-4901), vol. 43, Nov. 1984, p. 19-23. In German.

The simulation of a relevant system model provides a suitable tool for the analysis of complex dynamic systems, such as flight vehicle systems. Most of the employed computational programs, however, have been developed for applications involving given flight systems and specific problems. Such programs are little suited for a wider range of applications. The employment of simulation languages points in the direction of software with a more general applicability. In response to specific needs for such a program, it was decided to develop a general, portable flight vehicle simulation program which is easy to use. A description is provided of the first version of this program, which is called 'MISI'. Attention is given to the structure of MISI, the information flow, model and method definitions, the presentation and evaluation of computational data, the example of a guidance law study, the results of a computational analysis of the model, and future model extensions. G.R.

A85-18806

**COMPUTER-GRAPHICS: AN OVERVIEW - THE STATE OF THE TECHNOLOGY AT GENERAL DYNAMICS CONVAIR DIVISION**

J STAHL (General Dynamics Corp, Convair Div, San Diego, CA) Society of Allied Weight Engineers, Annual Conference, 42nd, Anaheim, CA, May 23-25, 1983. 7 p (SAWE PAPER 1514)

The evolution of CAD use at the Convair Division of General Dynamics is described. A Nova computer system with a 20 Mb drive and a four-pen plotter was purchased in 1975 and led to a waiting line of users and completely disordered tape archives. The system was expanded and access to system-level decisions was taken from the engineers. A different subsidiary assumed archiving and retrieval responsibilities and interfaced the system with a larger mass storage system. The system has grown from 6-350 users and is now a CAD/CAM operation. A user guide was published in 1979. The system is currently interactive among eight centers, and has become powerful enough so that numerical models have almost completely replaced prototype hardware. M.S.K.

A85-18807

**IDAS - AN INTERACTIVE DESIGN AND ANALYSIS SYSTEM**

D. A. ROBINSON (Rockwell International Corp, North American Aircraft Operations Div, El Segundo, CA) Society of Allied Weight Engineers, Annual Conference, 42nd, Anaheim, CA, May 23-25, 1983. 19 p. USAF-supported research (SAWE PAPER 1515)

This paper describes an interactive aircraft design system currently being developed. The system is known as IDAS and is comprised of geometric description, mass properties and aerodynamic analyses, performance and synthesis, and report modules. The design approach used for system development is the integration of existing programs into a single unit to provide a conceptual design tool which uses statistical (or level one) analysis techniques to initiate an aircraft design sequence prior to a more

detailed design study Interfaces to maintain database consistency and increase the depth of study are also to be included to allow continuation to a preliminary design level The system is being developed on a PRIME 750 minicomputer using Tektronix graphics terminals for design and graphic output and alphanumeric terminals for the remainder of the system. Author

**N85-14589#** Messerschmitt-Boelkow-Blohm G m b H., Hamburg (West Germany).

**INCREASE IN THE ECONOMY OF DESIGN AND PROCESS PLANNING BY INTEGRATED AND GRAPHIC DATA PROCESSING, PHASE 2 Final Report, Oct. 1983**

R. FEDDERSEN, U. GRUPE, and J. NAGEL (Dornier-Werke GmbH, Friedrichshafen, West Germany) Bonn Bundesministerium fuer Forschung und Technologie Jul 1984 143 p In GERMAN, ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie (BMFT-FB-W-84-028; ISSN-0170-1339) Avail NTIS HC A07/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 30

Software modules and interface programs were elaborated to rationalize the development and production of aircraft. Design, preliminary construction, detailed construction, weight and solidity calculations, production planning, and numerical control of production are covered As basic system for the graphical-interactive dialogs and the internal representations of objects the Lockheed CADAM system was used Author (ESA)

**N85-15450#** RAND Corp., Santa Monica, Calif.

**DYNA-SIM: A NONSTATIONARY QUEUEING SIMULATION WITH APPLICATION TO THE AUTOMATED TEST EQUIPMENT PROBLEM Interim Report**

L. W. MILLER, R. E. STANTON, and G. B. CRAWFORD Jul 1984 68 p (Contract F49620-82-C-0018) (AD-A146384; RAND/N-2087-AF) Avail: NTIS HC A04/MF A01 CSCI 15E

This note describes the Dyna-Sim model, which provides a capability for exploring the implications of maintenance repair queuing and requirements for spare parts. Several useful conclusions emerge from the study of the Automated Test Equipment (ATE) queuing problem using Dyna-Sim, which are summarized as follows. The ample server assumption (more than enough ATE available to serve any repair demands) is a very poor approximation when queues become saturated in high aircraft sortie rate scenarios, and if repair times follow the exponential distribution, certain approximation techniques become available (because the queuing system satisfies requirements of a Markov process) But real-world repair times are rarely exponential. The authors used Dyna-Sim to show that in a constrained server problem, the choice of the repair time distribution is not important. Thus, analytical approximations for queuing in capability assessment models are traceable. GRA

## PHYSICS

Includes physics (general), acoustics, atomic and molecular physics, nuclear and high-energy physics, optics; plasma physics; solid-state physics, and thermodynamics and statistical physics

**A85-16099\*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**SUPERSONIC JET SHOCK NOISE REDUCTION**

J. R. STONE (NASA, Lewis Research Center, Cleveland, OH) American Institute of Aeronautics and Astronautics, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct 15-17, 1984. 44 p. Previously announced in STAR as N84-35085 refs (AIAA PAPER 84-2278)

Shock-cell noise is identified to be a potentially significant problem for advanced supersonic aircraft at takeoff. Therefore NASA conducted fundamental studies of the phenomena involved and model-scale experiments aimed at developing means of noise reduction The results of a series of studies conducted to determine means by which supersonic jet shock noise can be reduced to acceptable levels for advanced supersonic cruise aircraft are reviewed Theoretical studies were conducted on the shock associated noise of supersonic jets from convergent-divergent (C-D) nozzles. Laboratory studies were conducted on the influence of narrowband shock screech on broadband noise and on means of screech reduction The usefulness of C-D nozzle passages was investigated at model scale for single-stream and dual-stream nozzles The effect of off-design pressure ratio was determined under static and simulated flight conditions for jet temperatures up to 960 K Annular and coannular flow passages with center plugs and multi-element suppressor nozzles were evaluated, and the effect of plug tip geometry was established In addition to the far-field acoustic data, mean and turbulent velocity distributions were measured with a laser velocimeter, and shadowgraph images of the flow field were obtained. Author

**A85-16103\*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**ANALYSIS OF THE EFFECT ON COMBUSTOR NOISE MEASUREMENTS OF ACOUSTIC WAVES REFLECTED BY THE TURBINE AND COMBUSTOR INLET**

R. G. HUFF (NASA, Lewis Research Center, Cleveland, OH) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984 11 p Previously announced in STAR as N84-32122. refs (AIAA PAPER 84-2323)

Spectral analyses of static pressure fluctuations measured in turbine engine combustors at low engine speed show good agreement with theory. At idle speed the high pressure turbine is unchoked. Above idle speed the turbine chokes and a significant change in the shape of the measured combustor pressure spectrum is observed A simplified theoretical model of the acoustic pressure generated in the combustor due to the turbulence-flame front interaction did not account for acoustic waves reflected from the turbine By retaining this simplified combustion noise source model and adding a partial reflecting plane at the turbine and combustor inlet, a simple theoretical model was developed that reproduces the undulations in the combustor fluctuating pressure spectra Plots of the theoretical combustor fluctuating pressure spectra are compared to the measured pressure spectra obtained from the CF6-50 turbofan engine over a range of engine operating speeds. The simplified combustion noise theory when modified by a simple turbine reflecting plane adequately accounts for the changes in measured combustor pressure spectra. It is further concluded that the shape of the pressure spectra downstream of the turbine, neglecting noise generated by the turbine itself, will be the combustion noise spectra unchanged except for the level reduction due to the energy blocked by the turbine Author

**A85-16104\*#** Missouri Univ, Rolla

**MODELLING OF WIND TUNNEL WALL EFFECTS ON THE RADIATION CHARACTERISTICS OF ACOUSTIC SOURCES**

W EVERSMAN (Missouri-Rolla, University, Rolla, MO) and K J BAUMEISTER (NASA, Lewis Research Center, Cleveland, OH) American Institute of Aeronautics and Astronautics and NASA, Aeroacoustics Conference, 9th, Williamsburg, VA, Oct. 15-17, 1984  
12 p refs

(AIAA PAPER 84-2364)

It is pointed out that the relatively high fuel economy available from propeller-driven aircraft has renewed interest in high speed, highly loaded multiple blade turboprop propulsion systems. Undesirable features related to community noise and the high intensity cabin noise have stimulated new research on the acoustic characteristics of turboprops. The present investigation has the objective to develop a mathematical model of the essential features of the radiation of acoustic disturbances from propellers in a duct and in free space in order to quantify the success with which duct testing can be expected to approximate free field conditions. In connection with the importance of source directionality, a detailed model is considered which consists of a finite element representation of the Gutin propeller theory valid in both the near and far field  
G R.

**A85-16187**

**PROPAGATION OF AN ION JET NEAR A DIELECTRIC SURFACE [RASPROSTRANENIE IONNOI STRUI VBLIZI DIELEKTRICHESKOI POVERKHNOСТИ]**

A. P. KURIACHII Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), Sept-Oct. 1984, p 174-180  
In Russian. refs

The electrical characteristics of a unipolarly charged jet propagating in a viscous incompressible gas near an ideal dielectric plate are calculated with allowance for surface and polarization charges, as well as for diffusion processes near the surface. An asymptotic solution to the equations of the diffusive ion layer is obtained in the case when the ratio of the diffusive-layer thickness to the thickness of the hydrodynamic boundary layer goes to zero. The results are pertinent to the static electrification of flight-vehicle surfaces  
L M

**A85-18513\*#** National Aeronautics and Space Administration Langley Research Center, Hampton, Va

**FLIGHT STUDY OF INDUCED TURBOFAN INLET ACOUSTIC RADIATION WITH THEORETICAL COMPARISONS**

J S PREISSER, R J SILCOX (NASA, Langley Research Center, Hampton, VA), W EVERSMAN (Missouri-Rolla, University, Rolla, MO), and A. V. PARRETT Journal of Aircraft (ISSN 0021-8669), vol. 22, Jan 1985, p 57-62. Previously cited in issue 6, p 837, Accession no A84-18132 refs

**A85-18514\*#** Hamilton Standard, Windsor Locks, Conn.

**PROPAGATION OF PROPELLER TONE NOISE THROUGH A FUSELAGE BOUNDARY LAYER**

D B HANSON and B MAGLIOZZI (United Technologies Corp., Hamilton Standard Div., Windsor Locks, CT) Journal of Aircraft (ISSN 0021-8669), vol. 22, Jan 1985, p 63-70. Previously cited in issue 6, p 836, Accession no A84-17975 refs  
(Contract NAS2-11325)

**N85-14664** Missouri Univ, Rolla

**APPLICATIONS OF FINITE AND WAVE ENVELOPE ELEMENT APPROXIMATIONS TO ACOUSTIC RADIATION FROM TURBOFAN ENGINE INLETS IN FLIGHT Ph.D. Thesis**

A. V. PARRETT 1984 142 p  
Avail Univ. Microfilms Order No DA8418569

The problem of acoustic radiation from turbofan engine inlets in flow has not lent itself fully to analysis by numerical means because of the large domains and high frequencies involved. The use of finite elements and wave envelope elements, elements which simulate decay and wavelike behavior in their interpolation functions were extended from the no-flow case in which they were proven, to cases incorporating mean flow. By employing an

irrotational mean flow assumption, the acoustics problem was posed in axisymmetric formulation in terms of acoustic velocity potential, thus minimizing computer solution storage requirements. The results obtained from the numerical procedures agree well with known analytical solutions and static jet engine inflow experimental data. Some discrepancy with flight test data exists but the combined finite element-wave envelope element solution radiation directivity trends are in good agreement with analytical predictions  
Dissert Abstr.

**N85-14666\*#** Bolt, Beranek, and Newman, Inc., Cambridge, Mass.

**SOURCES, PATHS, AND CONCEPTS FOR REDUCTION OF NOISE IN THE TEST SECTION OF THE NASA LANGLEY 4X7M WIND TUNNEL Final Report, Jul. 1983 - Mar. 1984**

R E HAYDEN and J F WILBY Sep 1984 325 p refs 2 Vol

(Contract NAS1-16521)

(NASA-CR-172446-VOL-1, NAS 1.26 172446-VOL-1, BBN-5416)

Avail NTIS HC A14/MF A01 CSCL 20A

NASA is investigating the feasibility of modifying the 4x7m Wind Tunnel at the Langley Research Center to make it suitable for a variety of aeroacoustic testing applications, most notably model helicopter rotors. The amount of noise reduction required to meet NASA's goal for test section background noise was determined, the predominant sources and paths causing the background noise were quantified, and trade-off studies between schemes to reduce fan noise at the source and those to attenuate the sound generated in the circuit between the sources and the test section were carried out. An extensive data base is also presented on circuit sources and paths  
R S F

**N85-14667\*#** Bolt, Beranek, and Newman, Inc., Cambridge, Mass.

**COMPARISON OF OPTIONS FOR REDUCTION OF NOISE IN THE TEST SECTION OF THE NASA LANGLEY 4X7M WIND TUNNEL, INCLUDING REDUCTION OF NOZZLE AREA Final Report, May - Jun. 1984**

R. E. HAYDEN Sep 1984 51 p refs 2 Vol

(Contract NAS1-16512-14)

(NASA-CR-172446-VOL-2, NAS 1.26 172446-VOL-2, TM-AS-44)

Avail NTIS HC A04/MF A01 CSCL 20A

The acoustically significant features of the NASA 4X7m wind tunnel and the Dutch-German DNW low speed tunnel are compared to illustrate the reasons for large differences in background noise in the open jet test sections of the two tunnels. Also introduced is the concept of reducing test section noise levels through fan and turning vane source reductions which can be brought about by reducing the nozzle cross sectional area, and thus the circuit mass flow for a particular exit velocity. The costs and benefits of treating sources, paths, and changing nozzle geometry are reviewed  
Author

## SOCIAL SCIENCES

Includes social sciences (general), administration and management; documentation and information science; economics and cost analysis; law and political science, and urban technology and transportation.

A85-17231#

**INITIAL EXPERIENCE WITH A THREE PLENUM CELL AIR CUSHION EQUIPMENT TRANSPORTER**

R. W. HELM (Bell Aerospace Canada Textron, Grand Bend, Ontario, Canada) (Canadian Symposium on Air Cushion Technology, 17th, Ottawa, Canada, Oct. 5, 1984) Canadian Aeronautics and Space Journal (ISSN 0008-2821), vol. 30, Sept. 1984, p. 256-262.

Design features and test plans for an air cushion equipment transporter (ACET) for carrying fully operational fighter aircraft over rough terrain between damaged and undamaged airfields are described. The ACET has three plenum cell cushions with air cushions supplied by a two-side mounted fan. Propulsion is supplied by the aircraft main engine and by towing by a vehicle such as a pick-up truck. An air filtration system protects the air intakes from object damage. Tapered skirts provide platform stability. The skirts are pleated with air cushions to prevent damage from collisions with ground obstacles. The ACET is capable of ferrying a 60,000 lb load. A fully equipped F-101B will serve as the test payload in trials that will cover accelerations of the center of gravity of the transporter and aircraft, pitch, roll and yaw rates, loads on the gear legs of the aircraft, force at the tow vehicle attach points, cushion pressure on each cell, and transporter speed. M.S.K.

N85-14718 Deutsche Lufthansa Aktiengesellschaft, Frankfurt am Main (West Germany)

**ACTIVITIES REPORT OF THE AEROSPACE INDUSTRY IN WEST GERMANY Annual Report [LUFTHANSA JAHRBUCH '84]**

H. J. ALLGAIER, ed. 31 May 1984. 313 p. refs. In GERMAN (ISSN-0176-5086). Avail: Issuing Activity

The development of the Deutsche Lufthansa AG between June 1983 and May 1984 is discussed. Passenger aircraft, costs, rates and regulation in civil aviation are presented. The structure of the Lufthansa group and participations are described. Lufthansa branches, training institutes and passenger operations are discussed. Author (ESA)

N85-15532# Naval Postgraduate School, Monterey, Calif.

**AN UPDATE OF THE FUNCTIONAL REQUIREMENTS OF THE NAVAL AVIATION LOGISTICS COMMAND MANAGEMENT INFORMATION SYSTEM (NALCOMIS) M.S. Thesis**

J. W. PUFFER. Mar. 1984. 85 p.  
(AD-A146565, AD-E440255). Avail: NTIS HC A05/MF A01  
CSCL 15E

Efforts to improve Naval Aviation readiness have taken the form of automated aviation maintenance management information systems. The Naval Aviation Logistics Command Management Information System (NALCOMIS) is a large complex system that has been in development since the mid 1970s. An interim system of a smaller scale, Status Inventory Data Management System (SIDMS), has been operational on Atlantic Fleet aircraft carriers for over two years. This thesis updates the functional requirements of NALCOMIS based on inputs from operational users of the interim system SIDMS. Data from questionnaires and structured personal interviews provide conclusions as to which functional requirements are most important/useful and which are least important/useful from a user point of view. The conclusions provide guidance for NALCOMIS implementation. Author (GRA)

## GENERAL

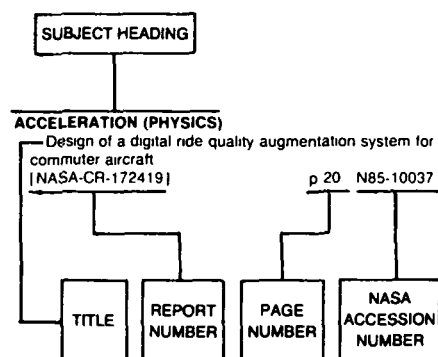
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**AEROSPACE HIGHLIGHTS 1984**

Aerospace America (ISSN 0740-722X), vol. 22, Dec. 1984, p. 24-27, 30-32, 34-36, (37 ff.).

Advances and activities in aerospace technologies and applications in 1984 are summarized. Attention is given to progress in aeroacoustics, maintenance, design techniques and tools, advanced materials, and power systems for space and atmospheric vehicles. Air transport systems are discussed, as are support systems, structures, software development, general aviation trends, lighter than air systems, and interactive computer graphics. Consideration is extended to digital avionics, applied aerodynamics, air breathing propulsion, and new avionics systems. CAD/CAM advances are described, along with five Shuttle missions, the NASA 'juke-box' 100 Mbps computer, expert systems, electric propulsion systems, solid rocket motors, and thermophysics experiments. Fluid dynamics, V/STOL aircraft systems, liquid propulsion, flight testing, structural dynamics research, propellants and combustion modeling and test beds, atmospheric flight dynamics studies, life sciences tests in space, and aircraft operations are explored. Finally, ground testing, flight simulation, space sciences, plasmadynamics, lasers, safety criteria, communications systems and management techniques are investigated. M.S.K.

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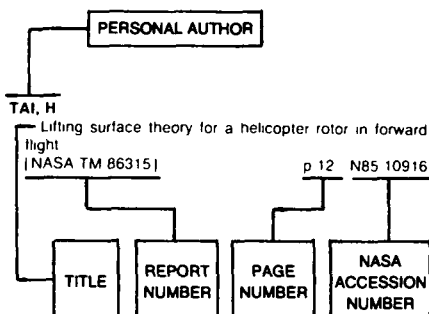
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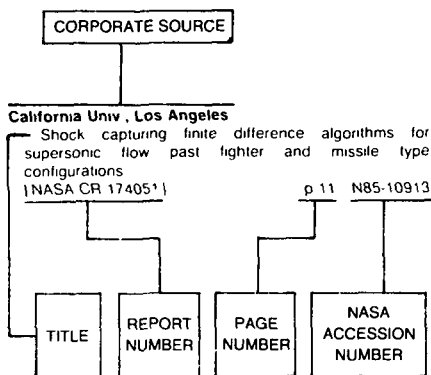
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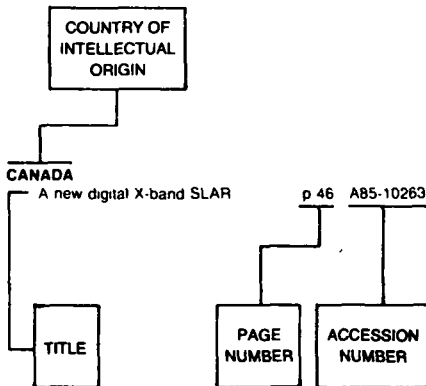
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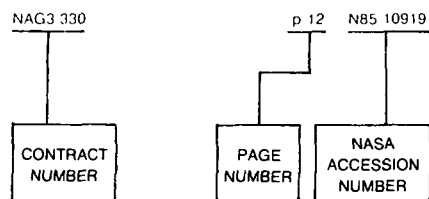
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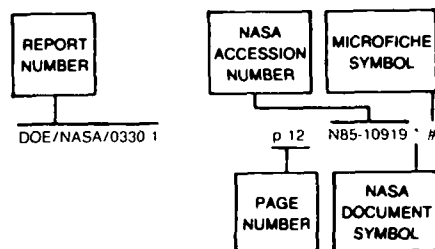
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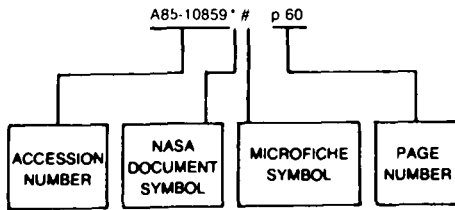
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